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Assessing the Redistributive Effect of Fiscal Policy

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Abstract

Who benefits from public spending? Who bears the burden of taxation? How desirable is the distribution of net benefits from the operation of a tax-benefit system? This paper surveys basic concepts, methods, and modeling approaches commonly used to address these issues in the context of fiscal incidence analysis. The review covers the incidence of both taxation and public spending. Methodological points are supported by country cases. The effective distribution of benefits and burdens associated with fiscal policy depends on the size of the government, the distributive mechanisms involved, and the incentives properties of the policy under consideration. This creates a need for analytical methods to account for both individual behavior and social interaction. The approaches reviewed include simple reduced form regression analysis, microsimulation models (both the envelope and discrete choice models), computable general equilibrium modeling, and approaches that link computable general equilibrium models to microsimulation models. Explicit modeling facilitates the construction of counterfactuals to back up causal analysis. Social desirability is assessed on the basis of progressivity along with deadweight loss.

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1. Introduction

Maintaining and improving the *living standard* of a population is commonly believed to be the ultimate objective of public policy and a fundamental expectation of the governed (Sen et al., 1987). The living standard of an individual hinges critically on both collective and individual choices. These choices shape available socioeconomic opportunities as well as the individual's willingness and ability to identify and exploit such opportunities. This view leads to two basic issues in public finance. What should be the appropriate role of government in pursuit of this fundamental policy objective? How should resources be mobilized and deployed to support the fulfillment of that role?

The appropriate role of the government should not be considered in a vacuum. It must be assessed in terms of its comparative advantage relative to the market. Stiglitz (1997) argues that whenever there are imperfections of information or competition or incomplete markets there is a potential for government actions to improve living standards. Essentially, he views the role of the government as establishing six types of infrastructure for the economy: educational, technological, financial, physical, environmental and social. This is consistent with the three functions of government proposed by Musgrave (1959) namely: *allocation*, *distribution* and *stabilization*. Accordingly, the government must intervene when market failure leads to Pareto inefficient outcomes (allocation); or when the private market outcome leaves some members of society with a level of living that is unacceptably low on the basis of prevailing norms (distribution[1]); or when some resources are left underutilized (stabilization).

Equity is the cornerstone of social infrastructure and certainly one thing that cannot be promoted by the private market. The World Development Report (WDR) 2006 argues for the pursuit of equity on both intrinsic and instrumental grounds. It defines equity in terms of a level playing field where individuals have equal *opportunities* to pursue freely chosen life plans and are spared from extreme deprivation in *outcomes*[2].

[1] In a market economy, each person's claim to available goods and services is limited to the amount of income obtainable from that person's successful sale of something of value on the market. Thus, distribution by the market system is based on *quid pro quo* (Lindblom 2001).
[2] Sen (1995) notes two broad dimensions to the concept of living standard. In this framework, the standard of living can be thought of in terms of human *functionings* and *capabilities*. Functionings represent the

This definition implies that the pursuit of equity also entails that of poverty reduction. While recognizing the intrinsic value of equity, the report emphasizes its instrumental value for development by noting the complementarities between equity and *prosperity*. Indeed missing or failing markets prevent resources from flowing where returns would be highest. If correcting such failures is not feasible or is too costly, then improved efficiency can be achieved through some form of redistribution of access to services, assets, or political influence. It is further noted that inequitable institutions stemming from high levels of socio-political inequality can lead to high economic costs to the extent that such institutions tend to favor systematically powerful interest groups.

The purpose of this paper is to review basic concepts, methods and tools used in assessing the redistributive effect of public finance. Empirical examples will also be discussed along the way. *The key issue of concern here is the appropriate distribution of the tax burden and the benefits from public expenditure*. It is instructive to frame such an evaluation within the broader logic of an *allocation or distribution problem* which arises in situations where a bundle of resources or burdens must be allotted individually to members of a group. Young (1994) explains that such a problem can be analyzed in terms of the following three dimensions: (1) a *supply decision* by the relevant institution that determines the amount of the good or burden to distribute; (2) a *distributive decision* based on a set of the principles governing the allotment process (i.e. assignment of shares to eligible individuals); and (3) *reactive decisions* made by individuals in response to the incentives created by the above two institutional choices.

In the context of taxation for instance, the supply dimension relates to the determination of the amount of tax to be levied given the desired level of expenditure. The personal income tax schedule is an outcome of a distributive rule which is usually based on the principle of progressivity. Accordingly, the amount of tax owed by a household is generally a function of its ability to pay. This ability is assessed on the basis

various living conditions achieved by an individual (i.e. outcomes), while capabilities relate to the ability of achieving functionings. Capabilities define the freedom of choice, hence the opportunity set. Given this fundamental distinction, WDR 2006 argues that public policy should seek to equalize opportunities, not outcomes. However, high inequality of outcomes across groups defined on the basis of circumstances beyond their control, is viewed as evidence of unequal opportunities.

of the socioeconomic characteristics of the household[3]. The basic neoclassical model of labor supply provides a convenient framework to illustrate the response of taxpayers to the rate structure. In this framework, labor supply is a consequence of optimal choice between income (or consumption that this income can buy) and leisure. The imposition of a tax on earnings reduces the after-tax wage and hence, induces the taxpayer to want to work less (i.e. consume more leisure). This is the *substitution effect*. On the other hand, there is an *income effect* due to the fact that taxation reduces the worker's level of income. The taxpayer would want to work more to compensate for that loss. The overall response to taxation will thus depend on which effect dominates.

Accounting for the behavioral response of socioeconomic agents to public policy is essential to minimize bias in the estimation of policy impact, and hence to avoid erroneous policy recommendations. This accounting is also necessary for a proper evaluation of government intervention. As noted by Stiglitz (1997), public intervention is warranted if it is aimed at a serious imperfection in the market place and it is designed in such a way that the perceived benefits outweigh the costs. An important dimension of these costs is represented by the concept of *excess burden*. This is the efficiency loss associated with change in behavior induced by distorted incentives due to policy implementation. Taxation, for instance, leads to a change in relative prices that can distort choices. As a result socioeconomic agents experience welfare costs, which, when translated in money, exceed the amount of tax paid (Creedy 2004).

The outline of the paper is as follows. Section 2 focuses on the distribution of the *tax burden*. It starts with a discussion of standard incidence analysis. In general, this involves a positive analysis of the impact of public policy on the distribution of economic welfare within society. In the particular case of taxation, the object of incidence analysis is to determine who ultimately bears the economic burden of taxation and to what extent.

[3] Generally speaking, an *allocation rule* is a method of determining individual shares (in a distribution problem) on the basis of the nature of the good or burden, and the relevant characteristics of the claimants (Young 1994). For instance, the benefit principle of taxation stipulates that citizens should be taxed on the basis of their *willingness to pay* for public services. This is the idea underlying the Lindhal tax. Given an optimal level of provision of a public good, the Lindhal tax for each person is equal to that optimal level times her or his willingness to pay for an extra unit of the good. The optimal quantity of the good is the level at which the marginal cost of provision is equal to the overall willingness to pay. However, the benefit approach to taxation is vulnerable to the *free-rider* problem. There is incentive for everybody to underreport her willingness to pay.

In this context, it is important to keep in mind the distinction between the *statutory incidence* of a tax and its *economic incidence*. The former identifies the person who is obligated by law to remit a tax payment to the government while the latter refers to changes in economic well-being resulting from changes in behavior and equilibrium prices induced by taxation. Various incidence assumptions made in tax incidence analysis will be reviewed in this section, which also covers issues related to equity in the distribution of the tax burden.

The discussion of these equity issues will be organized around the concept of *progressivity* and its connections to vertical and horizontal equity. In general, a progressive policy favors the poor relative to the non-poor. In the particular context of income taxation, a progressive tax is such that the average tax burden faced by an income unit is an increasing function of income. Thus a better-off taxpayer would not only have a bigger tax liability but also pay a bigger share of his income in tax. Given a pre-tax income distribution, a progressive tax shifts part of the tax burden from low to high incomes. In so doing it exerts a redistributive effect on the distribution of income. This redistributive effect can be viewed as a shift of part of total post-tax income from high to low income recipients (Lambert 2001). The shifting of the tax burden is known as the *disproportionality* effect[4]. Both this and the redistributive effect underpin the measurement of progressivity. We will consider the links between progression, horizontal and vertical equity in the context of unequal treatment of pre-tax equals[5]. To the extent feasible, some of these concepts will also be translated in the context of non-income tax.

Section 3 of this review focuses on the *incidence of public expenditure*. One policy conclusion that emerges from tax incidence studies reveals the limited ability of tax policy to significantly change the distribution of income (Martinez-Vazquez 2008). This situation shifts the redistributive function of fiscal policy on public spending. The potential impact of public expenditure on the distribution of economic welfare depends on the level and type of spending as well as on the efficiency of such spending.

[4] As income increases, the tax burden increases more than proportionately.

[5] Lambert (2001) argues that progression is a meaningful feature of income taxation only in the case of social homogeneity, i.e. all income units are of the same type. It therefore makes sense to model tax liability as a function of income alone.

Expenditure incidence analysis is mainly concerned with public spending designed to improve equity. In this section, we review the main methods used to assess the distributional impact of public expenditure. The general approach to benefit incidence analysis is analogous to tax incidence analysis. It is a matter of identifying who benefits from public spending and ascertaining the social desirability of the resulting distribution of benefits. This section also reviews simple methods of accounting for behavioral responses to public spending. Finally we discuss the combined incidence of taxes and public spending.

A key methodological message emerging from this review relates to the important role played by individual behavior and social interaction in determining fiscal incidence. Accordingly, section 4 of this review focuses on modeling frameworks currently used in fiscal incidence analysis. It starts out with a discussion of two categories of microsimulation models. The first is based on the envelope theorem of consumer theory while the second is framed within the logic of random utility models. The section ends with a review of fiscal incidence analysis within a general equilibrium framework. It considers respectively analytical and applied models, and ways of linking a computable general equilibrium (CGE) model to a microsimulation module.

Concluding remarks are made in section 5, focusing on methodological as well as on policy lessons.

2. The Burden of Taxation

The burden of taxation is the change in individual and social welfare induced by a tax system. When real income is used as an indicator of economic welfare, the tax burden is measured by loss in real income[6]. Who really bears the burden of taxation? How desirable is the effective distribution of the tax burden? These two questions underlie the evaluation of the distribution of the tax burden in a given society. In this section, we review concepts and methods designed to help answer these basic questions. *Tax incidence* analysis seeks to identify the people who ultimately bear the tax burden.

[6] Hence, the burden depends on real allocations and not on the price level or choice of *numéraire*. What matters in the context of incidence analysis is how changes in relative output prices and relative factor prices affect policy-relevant socioeconomic groups (Fullerton and Metcalf 2002).

Social desirability is a matter of value judgments. Here we focus on *progressivity* to assess fairness on the basis of ability to pay. Finally, we note that progressivity comes at a cost since there is a welfare loss associated with distortions induced by taxation.

2.1. Tax Incidence

Tax Shifting

To obtain the effective distribution of the tax burden, it is necessary to identify as accurately as possible the people who end up bearing the burden of the tax in question and the extent of their share of that burden. In general, taxes are imposed on economic transactions along the production and distribution chain. *Tax shifting* reflects the fact that the imposition of a tax at a particular point on this chain may end up affecting economic welfare of people at different points. The possibility of shifting the tax burden stems from the fact that socioeconomic agents can change their *behavior* in response to a tax, subject to the prevailing *institutional arrangements*. In a market economy, the burden of taxation is channeled mainly through changes in the prices of traded goods and services. Thus, people bear the burden of a tax when the imposition of the tax induces a change in the relative prices of the goods and services they buy and sell[7]. In addition, a tax may affect the prices of untaxed goods and services that are substitutes or complements of the taxed ones. Such price changes are interpreted as "implicit" taxation.

As a rule of thumb, the extent to which a tax can be shifted and hence who ends up bearing the burden depend on the alternatives available to the parties in the taxed transaction. Thus, one is less likely to bear the tax burden when he or she has better alternatives to what is taxed (Slemrod and Bakija 1996). In the case of taxes on labor income, leisure or unpaid work at home are the alternatives open to workers. For the employers, the alternative to hiring workers is determined by the ability to switch to more capital-intensive modes of production. Thus, a tax on labor income can be shifted to the employers if workers have better alternatives than employers. The same principle applies to other categories of taxes. For instance, the estimation of the distribution of the burden

[7] In a market economy, changes in prices affect agents' demand and supply behavior, as well as their revenue and welfare.

of the corporate income tax entails an analysis of the interaction between stakeholders, employees and costumers. One possibility is that the stockholders would bear the burden in the short run. In the medium to long run, changes in stock prices will make non-corporate investments more attractive. The returns in the non-corporate sector will fall due to increase demand. This represents some shifting of the burden of the corporate income tax to holders of other forms of wealth.

In a particular market, the degree of shifting depends on the elasticity of demand and supply, and on market structure. Stern (1987) demonstrates how this works for a specific tax[8] within a partial-equilibrium framework. Let **t** stand for a tax per unit of output in a competitive market. If **q** is the consumer price, the producer price is given by $p = (q - t)$. Furthermore, let **η** and **ε** stand respectively for the elasticity of supply and that of demand. The effect of this tax on prices is defined by the following expressions. For the consumer price, we have: $\frac{dq}{dt} = \frac{\eta}{\eta + \varepsilon p / q}$. The effect on the producer prices is: $\frac{dp}{dt} = \frac{-\varepsilon}{\varepsilon + \eta q / p}$. For small taxes, the producer price is very close to the consumer price so that the proportion of the tax that is shifted to consumers can be approximated by the following expression: $\frac{\eta}{\varepsilon + \eta}$. In general, the more inelastic part of the market will bear the greater share of the tax burden[9]. For instance, if the demand elasticity is equal to zero, the consumer will bear 100 percent of the tax burden. In a similar fashion, the incidence of a payroll tax can be analyzed in terms of supply and demand elasticities (Salanié 2003; Fullerton and Metcalf 2002).

Incidence Assumptions

Because economic agents can change their behavior in response to taxation and thereby shift the tax burden to other actors, it is evident that the allocation of the tax

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[8] A specific tax (t) adds a given amount of money to a unit price of a good or factor. It thus raises the price from p to (p+t). An *ad valorem* tax (τ) is assessed as a fraction of the unit price. In this case, the price changes from p to p(1+τ).

[9] Fullerton and Metcalf (2002) note that, in a perfectly competitive market, the economic incidence of a tax depends exclusively on behavior and not on legislative intent.

burden to policy-relevant socioeconomic groups[10] hinges critically on the assumptions made about this behavior and the interaction among economic agents. It is difficult in practice to obtain an accurate estimate of tax shifting. Most empirical studies rely on data on the sources and uses of income in each socioeconomic group to construct the distribution of the tax burden on the basis of some assumptions about incidence. The quality of the results thus depends on the extent to which such assumptions are reasonable and defensible (Slemrod and Bakija 1996).

Martinez-Vazquez (2008) describes a set of assumptions used in conventional tax incidence analysis. Given that the role of incidence assumptions is to facilitate the allocation of the tax burden to different income groups, they rely heavily on the fact that income sources and expenditure patterns vary significantly among such groups. For instance, one can expect income from capital to be concentrated in the highest tail of the income distribution. In certain countries, this component of income can also be found in the lowest end of the distribution due to retired workers who may be living off their past savings.

The typical assumptions include the following. (1) personal income tax is paid by the income recipient; (2) the burden of payroll and social security taxes fall entirely on workers; (3) three categories of assumptions can be made about the shifting pattern of corporate income taxes: (a) shareholders bear the full burden, (b) all capital owners bear the burden due to equalization of after-tax rates of return on all forms of capital, (c) half of the burden rests on all owners of capital and the other half is passed on to consumers in the form of higher consumer prices; (4) consumption taxes are fully shifted to consumers. In general, conventional analysis assumes that the burden of direct taxes falls on the owners of factors of production, while the burden of indirect taxes is borne fully by consumers (Martinez-Vazquez 2008).

These assumptions have also been made in the case of Chile (Engel, Galetovic and Raddatz 1999). These authors also assume that business tax is not passed on to consumers based on the observation that all types of businesses are subject to this tax. Table 2.1 shows their results in terms of the distribution of the tax burden in 1996 by

[10] One conventional type of socioeconomic groups used in incidence analysis is to order the population in increasing order of some welfare indicator (e.g. income or consumption expenditure) and allocate individuals to income deciles or quintiles.

deciles. The second and third columns of this table show the distribution of both pre-tax and after-tax income. The wealthiest deciles receives more that 40 percent of pre-tax income and about 41 percent of after-tax income while the poorest receives about 1.4 percent of each type of income.

Table 2.1. The Distribution of the Tax Burden in Chile (1996)

Decile	Pre-Tax Income	After-Tax Income	Whole Tax System	Income Tax	VAT	Other Taxes
1	1.45	1.40	14.44	0.00	11.0	3.42
2	2.74	2.63	16.0	0.00	11.8	4.20
3	3.77	3.61	15.8	0.00	11.4	4.33
4	4.73	4.59	15.2	0.00	10.9	4.25
5	5.57	5.47	15.0	0.01	10.7	4.21
6	6.76	6.64	14.3	0.04	10.2	4.07
7	8.22	8.20	13.8	0.11	9.7	4.0
8	10.60	10.61	13.1	0.23	9.0	3.85
9	15.42	15.75	12.2	0.62	8.0	3.54
10	40.75	41.09	11.8	2.54	6.3	2.96

Source: Engel, Galetovic and Raddatz (1999); Note: the entries are in percentage.

The last three columns of the table show the percentage of income that each decile pays in taxes considering respectively the whole tax system, the income tax, the value-added tax (VAT) and other taxes. These results reveal the tax burden is disproportionately borne by the poor. For instance, the second decile is the group that pays the highest percentage of its income in taxes, 16 percent compared to the 12 percent paid by the wealthiest group.

Shah and Whalley (1991) caution that, a mechanical application of the conventional incidence analysis to developing countries can lead to significantly erroneous results and hence to wrong policy recommendations. Indeed, this standard analysis assumes an institutional setting that may not prevail in developing countries, namely a competitive market economy. For a proper tax incidence analysis in developing countries, these authors urge that account be taken of the following special features such as: informal sector, rural-urban migration, credit-rationing, extent of unionization, tax evasion, foreign and public ownership of firms. The presence of these factors requires special shifting assumptions, which may reverse the incidence pattern implied by conventional assumptions. For instance, effective price controls may prevent producers from shifting sales and excise taxes to consumers, thus rendering invalid the conventional assumption that such taxes are fully shifted forward to consumers. Rural-urban migration may lead to a partial shift of income tax burden from urban onto rural workers. This cautionary note from Shah and Whalley underscores the importance of modeling explicitly and accurately individual behavior and social interaction in improving the estimation of the distribution of the tax burden. We review modeling issues in section 4 of this paper.

2.2. Progressivity

Incidence analysis as discussed above is largely a *positive* exercise designed to reveal who bears the burden of taxation, and hence the distribution of that burden. The next issue of interest relates to social desirability of the observed distribution of the tax burden. As noted in the introduction, this is a *normative* issue that must be settled on the basis of chosen value judgments. The progressivity principle is based on vertical equity (VE) which requires that differences in people's circumstances be appropriately taken into account in both the formulation and implementation of public policy.

It is commonly accepted that the tax burden must be distributed according to an indicator of the ability to pay (usually some indicator of the living standard). In particular, a progressive income tax is imposed in such a way that taxpayers at higher income brackets pay a higher proportion of their income in taxes. The principle of horizontal equity (HE) requires an equal treatment of pretax equals. We will see that the violation of this principle reduces the redistributive effect of a progressive tax[11].

This section focuses on three topics: (1) measurement, (2) incentive properties, and (3) the ability of a tax system to redistribute income and wealth. The discussion of

[11] In the case of income taxation, Lambert (2001) notes that if, by "identical circumstances" we mean "identical income levels", then a tax schedule that is a function only of income will ensure horizontal equity, regardless of its progressive nature.

measurement issues will be based mainly on a simple income tax model where the relevant population is assumed to be socially homogeneous with respect to non-income attributes. This implies that tax liability will be the same for income units with the same level of income. The model further assumes that both tax and after-tax income are increasing function of pre-tax income[12] (Lambert 2001). The results derived from this simple model will then be generalized to the case of social heterogeneity.

Table 2.2: Alternative Tax Options for Australia

Expenditure Group	Option A	Option B
Clothing and Footwear	0.30	0.30
Furniture and Appliances	0.30	0.30
Motor Vehicles and Parts	0.40	0.30
Recreation Items	0.20	0.30
Miscellaneous	0.20	0.30
House-Building Payments	0.40.	0.30

Source: Creedy (2001)

Measurement

The burden associated with a progressive tax is disproportionately distributed in favor of the worse off while exerting an equalizing effect on the distribution of the living standard. Measures of progressivity can therefore be developed either from the disproportionality effect or from the equalizing effect of the tax under consideration. In the case of income tax, assuming a homogeneous population with respect to tax-relevant attributes such as marital status or family size, progressivity can be established by plotting the ratio of the amount paid in tax to income against income. If this is an increasing function, the tax is progressive. It is a decreasing function of income for a regressive tax[13]. The ratio is constant for a proportional tax. Lambert (2001) explains

[12] Analytically, this model can be represented by a tax function t(x) with the following properties: $0 \le t(x) < x; 0 \le t'(x) < 1$, where x represents pre-tax income.

[13] One can also measure the degree of tax progression along income scale by considering the so-called measures of local or structural progression. One such measure compares the marginal and average tax rates. For a tax schedule to be progressive, it is necessary and sufficient to have the marginal rate greater than the average rate for all income levels (Lambert 2001).

that any progressive income tax is equivalent to a flat tax of equal yield combined with appropriate rich-to-poor transfers.

Table 2.3. Ratio of Equivalent Variations to Total Expenditure

Weekly Expenditure	Option A	Option B
200	0.075	0.078
400	0.098	0.102
600	0.116	0.118
800	0.128	0.129
1000	0.138	0.138
1200	0.147	0.145
1400	0.160	0.157

Source: Creedy (2001)

The impact of indirect taxes on individual welfare is channeled through changes in commodity prices. This suggests the use of welfare measures such as equivalent variation (EV) or compensating variation (CV) as indicators of tax burden. These two measures can be defined in terms of the expenditure function which represents the minimum level of expenditure required to achieve a given level of utility given the prevailing prices (Deaton and Muellbauer 1980). Denote this function by **e(p,u)**, where **p** is a vector of prices and **u** stands for utility. If a tax induces a price change from $\mathbf{p^0}$ to $\mathbf{p^1}$, the equivalent variation is the maximum an individual would be willing to pay to avoid the tax and the associated change in prices. This can be formally written as: $EV = [e(p^1, u^1) - e(p^0, u^1)]$. Analogously, the compensating variation is the minimum amount of income an individual should be given in compensation for the price change in order to keep her as well off as before the change. Formally, this is defined as: $CV = [e(p^1, u^0) - e(p^0, u^0)]$. Creedy (2001) uses the ratio of equivalent variation to total expenditure to assess the progressivity of alternative indirect tax structures in

Australia. The two regimes tax only goods whose budget shares rise with income. Table 2.2. gives the expenditure groups[14] and the associated tax rates

Table 2.3 show normalized equivalent variations for a range of weekly total expenditure in dollars. Both tax options would be progressive since the normalized EV increases with the level of expenditure.

The disproportionality property of the tax burden can also be established by comparing concentration curves. Let **x** and **y** be any two attributes of income units e.g. pre- and post-tax income levels. Suppose that the population is ranked in increasing order of **x**, so that **p** represents the lowest 100**p** percent of the distribution of **x**. For each **p** between zero and one, the concentration curve for **y** with respect to **x** shows the share of **y** going to this lowest percentile. Let $\mathbf{L_X(p)}$ be the Lorenz curve of pre-tax income and $\mathbf{K_T(p)}$ the concentration curve for tax payments. The term $\mathbf{A(p)= [L_X(p) - K_T(p)]}$ measures the distance between the two curves. The distance measures, for the lowest-ranked 100**p** percent of the population, the difference between their share in pre-tax income and their share in the tax burden.

If this is positive for all **p**, the concentration curve for tax payments lies entirely below the pre-tax income Lorenz curve. In other words, the lowest-ranked 100**p** percent of income units receive a greater share of pretax income than of the tax burden (Lambert 2001). To better understand the departure from proportionality in the distribution of the tax burden, note that $\mathbf{L_X(p)}$ also represents the concentration curve for tax liabilities under an equal-yield flat tax. Under this interpretation, **A(p)** represents the fraction of the tax burden shifted from low to high incomes. The Kakwani index of progressivity is equal to twice area under **A(p)**. This reduces to the difference between the concentration coefficient for tax liabilities and the Gini coefficient for pre-tax income, and can be written explicitly as: $\pi_K = C_T - G_X$.

Analogously, the progressivity of a tax can be assessed on the basis of its equalizing or redistributive effect. This entails the comparison of pre-tax income distribution with that of post-tax income. Let $\mathbf{K_Y(p)}$ stands for the concentration curve of

[14] These six expenditure groups form a subset of 14 expenditure components considered by the author. The non-taxed groups include: Current housing costs; electricity, gas and other fuels; food and non-alcoholic beverages; spirits, beer and wine; tobacco; postal and telephone charges; health services; and personal care products.

the after tax income distribution. Now, **B(p)= [K_Y(p) - L_X(p)]** shows the fraction of post-tax income shifted from high to low incomes by the tax. This term is positive for a progressive tax. This characterization is based on interpreting **L_X(p)** now as the concentration curve for after tax income induced by an equal-yield flat tax (Lambert 2001). The Reynolds-Smolensky index of the redistributive effect is equal to twice the area under **B(p)**. It reduces into the difference between the Gini coefficient of pre-tax income and the concentration coefficient of the after tax income, and can be written as: $\pi_{RS} = G_X - C_Y$.

Lambert (2001) shows that the measure based on the equalizing effect and the one based on disproportionality are related through the following relation, where **g** stands for the overall average tax rate (or the total tax ratio): $K_Y - L_X \equiv \frac{g}{1-g}\left(L_X - K_T\right)$. Hence, $\pi_{RS} \equiv \frac{g}{1-g}\pi_K$. In other words, the amount of income shifted down the income scale by a progressive tax is a function of the total tax ratio and the disproportionality effect.

It is important to note that the above results hinges on the assumption of social homogeneity and the fact that the marginal tax rate is less than one. Under these restrictive assumptions, **K_Y(p)** is also the Lorenz curve of post tax income distribution. This is why we were able to call **B(p)** the redistributive effect. When the tax system accounts for social heterogeneity, the tax schedule will depend on income and non-income attributes such as marital status and family size. In this general case, reranking of income units can occur. Now, let **L_Y(q)** stand for the Lorenz curve of the post tax income distribution. The redistribution effect can now be written as follows (Lambert 2001):

$$L_Y - L_X \equiv \frac{g}{1-g}\left(L_X - K_T\right) - \left(K_Y - L_Y\right) \tag{2.1}$$

The above relation implies the following:

$$G_X - G_Y \equiv \frac{g}{1-g}\left(C_T - G_X\right) - \left(G_Y - C_Y\right) \tag{2.2}$$

The above two expressions apply to any tax system beyond the simple model we started with. The left hand side of (2.2) now represents the Reynolds-Smolensky index of the redistributive effect of the tax. The first term on the right hand side of the same expression is a function of Kakwani's index of progressivity. The last term on the right reflects the extent of reranking in the transition from the pre-tax to the post-tax income distribution[15].

Aronson, Johnson and Lambert (1994), here after AJL, show that when tax liabilities are determined on the basis of income and non-income factors, differences in tax treatment at given levels of (equivalent) income are bound to arise. On top of this possible unequal treatment of equals, the tax system may also imply reranking among unequals. These authors demonstrate[16] that the redistributive effect of a tax, $RE = G_X - G_Y$, can be written as a function of three factors: (1) the vertical or progressivity effect (**V**), (2) a measure of classical horizontal inequity (**H**), and the Atkinson-Plotnick index of reranking (**R**). Formally, we have:

$$RE = V - H - R \tag{2.3}$$

Assuming that the population has been divided in groups of pretax equals, the various components of (2.3) are defined as follows. $V = (G_X - G_b)$, where G_b the between group Gini coefficient of the distribution of post-tax income. Classical horizontal inequity is measured by: $H = \sum_k \alpha_k G_k$, where $\boldsymbol{\alpha_k}$ is the product of the population share and the post-tax income share in group **k**, and $\mathbf{G_k}$ is the Gini index of inequality in the distribution of after-tax income in group **k**. Reranking is given by the last term in (2.2): $R = (G_Y - C_Y)$. The fact that these components are positive implies that both horizontal inequity and reranking reduce the vertical or progressivity effect.

Hyun and Lim (2005) use the AJL methodology to examine the redistributive effect of the Korean income tax system over three years: 1991, 1996 and 2000. Their empirical results based on microdata sets collected by the Korean National Statiatical office are presented in table 2.4. The last three rows of this table show the normalized version of the three components of the redistributive effect as a percentage of RE. The

[15] It is important to keep in mind that in the benchmark model of income tax where both tax and post-tax income increase with pre-tax income, there is no reranking as we move from the pre-tax to the post-tax distribution of income. In other words, the benchmark case implements a rank-presenving transformation of pre-tax incomes into post-tax income.

[16] Their demonstration hinges on the following decomposition of the Gini coefficient of post-tax income distribution: $G_Y = G_b + \sum_k \alpha_k G_k + R$.

results show a positive redistribution effect for each year since the Gini coefficient falls after tax. The pattern of the distribution of the equalizing effect across the vertical, horizontal and reranking components is similar over the three years. The results also indicate a fairly high level of horizontal inequity. Using 1991 as base year, the authors

Table 2.4. The Redistributive Effect of Income Tax in Korea

Indicator	1991	1996	2000
Gini before tax	0.34718	0.33682	0.40077
Gini after tax	0.32455	0.31877	0.37899
RE	0.0222631	0.018041	0.021782
Kakwani	0.41158	0.40158	0.42643
Average Tax Rate	0.065178	0.066025	0.069124
V	0.028697	0.028389	0.028033
H	0.00523	0.008924	0.005491
R	0.000836	0.001424	0.000760
V(%)	126.8	157.35	128.70
H(%)	23.11	49.46	25.20
R(%)	3.7	7.89	3.49

Source: Hyun and Lim (2005)

make a normalized comparison of these components over time. They find that the redistributive effect was highest in 1991 and lowest in 1996. They explain the 1996 outcome by observing that it is also the year with the highest level of horizontal inequity. In general, they conclude that there is room for improving the redistributive power of income tax in Korea by abolishing most allowances and exemptions.

To confirm that the AJL methodology applies equally well to indirect taxes, we present in table 2.5 the results of an evaluation of the redistributive effect of the pre-2000 indirect tax system in Australia by Creedy (2001). To account for demand responses, the author derives demand elasticities and welfare changes on the basis of a linear expenditure system (LES) using data on the socioeconomic groups listed in table 2.5. The 14 expenditure components include those listed in table 2.2 and in footnote 14. However, the author explains that the computation of the three components of redistribution presented in table 2.5 does not account for demand changes in order to maintain the full variation of household budget shares. It is this heterogeneity in budget shares that explains horizontal inequity and reranking.

The redistributive effect shown in the second column of table 2.5 reveals that the pre-2000 indirect tax system in Australia was slightly regressive overall and for most household types except for couples with no children and at least one retiree and for single retirees. Reranking is more substantial than horizontal inequity. It can be noted that the favorable redistribution towards type 3 and type 10 household would be more significant in the absence of the reranking effect. Reranking reduces redistribution for type 3 by about 32 percent and by 22 percent for type 10. The largest amount of reranking is observed for single parents with one dependent child. The author explains that this reranking is largely due to exemptions working through heterogeneous budget shares.

Table 2.5. The Redistributive Effect of Indirect Taxes in Australia

Household type	RE	V	V(%)	H(%)	R(%)
1. All households	-0.0013	-0.0009	71.39	0.66	27.94
2. Couple, no children	-0.0021	-0.0017	80.55	0.05	19.39
3. Couple, no children, at least one retired	0.0018	0.0025	132.84	1.32	31.53
4. Couple, one dependent child	-0.0017	-0.0013	76.29	1.45	25.16
5. Couple, two dependent children	-0.0013	-0.0010	75.77	1.51	25.74
6. Couple, three or more dependent children	-0.0027	-0.0024	87.56	0.13	12.57
7. Single parent, one dependent child	-0.0013	-0.0008	64.17	2.42	38.25
8. Single two or more dependent children	-0.0020	-0.0016	79.29	1.92	18.79
9. Single, not retired	-0.0038	-0.0032	84.91	0.35	15.44
10. Single, retired	0.0029	0.0036	123.46	1.27	22.19

Source: Creedy (2001)

Urban and Lambert (2008) explain that the AJL machinery reviewed above works only when applied to groups of exact equals. They observe that typical real-world datasets rarely contain exact equals. In such circumstances, analysts use groups of close equals to identify the horizontal effect of a tax system. Such groups are defined on the basis of a chosen bandwidth that determines the maximum difference between the pre-tax incomes of any two individuals considered as near equals. Urban and Lambert identify three distinct forms of reranking that are bound to arise in the case of close equals. In moving from pre-tax to post-tax distribution of income, the following types of reranking may take place: within-group reranking, entire-group reranking, and the type of reranking encountered in the AJL framework.

These components of reranking can be identified through the following process fully described by the authors. Start with income units ordered by pre-tax income, and select a bandwidth to create close equals groups. Now, consider ordering units within each group only according to post-tax income. The comparison of the resulting distribution with the initial one identifies *within-group reranking*. Starting now with the new distribution (that accounts for within group reranking), reorder whole groups in increasing order of group mean post-tax income (i.e so that the group mean post-tax income increases monotonically from one group to the next). The transition from the precedent distribution to this new one reveals *entire-group reranking*. Finally, sort this last distribution in increasing order of post-tax income. The comparison of the result with the distribution from which it was derived reveals the AJL reranking. The phenomenon of significance at the last step is that some income units can "get out" of their original group and take up positions in different groups.

What then are the implications for the computation of the components of the redistributive effect? We present here the key methodological recommendation proposed by the authors. The measurement framework relies on the comparison of Lorenz and concentration curves associated with transitional distributions from pre-tax to post-tax income distribution and various orderings of income units. In this context, they refer to the vertical effect as the *full vertical effect* and to the appropriate horizontal effect as *type 2 horizontal effect*[17]. The reranking effect that includes all three forms described above is called the Atkinson-Plotnick-Kakwani (APK) reranking[18].

[17] Type one reranking is associated with AJL methodology. In that case horizontal inequity refers to inequality in the distribution of post-tax income among exact equals. Type 2 is assessed on the basis of person-by-person departure of actual post-tax income from a counterfactual distribution free of horizontal inequity (Urban and Lambert 2008).

[18] The three forms of reranking can be computed separately as follows. Compute the Lorenz curve of pre-tax income based on an ordering that ranks income units by pre-tax income level and exact equals by post-tax income level. Call this ordering 1 and compute the concentration curve of post-tax income associated with this ordering. Next, consider the ordering of income units by post-tax income level. Call this ordering 2 and compute the Lorenz curve of the distribution of post-tax income. The APK reranking is based on the comparison of the concentration curve of ordering 1 with the Lorenz curve of post-tax income. It can be

The computation of both the full vertical and type two horizontal effects entails a counterfactual distribution. Given the pre-tax and post-tax distributions, order income units by pre-tax income level, breaking possible ties with post-tax income (i.e. exact equals, if any, are ranked by post-tax income). Compute the Lorenz curve of pre-tax income (L_X) and the concentration curve of post-tax income ($\mathbf{K_Y}$) associated with this ordering. Compute the Lorenz curve for post-tax income ($\mathbf{L_Y}$) as well. Let $\mathbf{g_k}$ be the share of total pre-tax income taken from a given group of close equals (k=1,2,…m). The counterfactual income distribution, $\mathbf{Y_c}$, is obtained by reducing the pre-tax income in each group by the relevant fraction $\mathbf{g_k}$. Compute also the concentration curve of this counterfactual distribution ($\mathbf{K_C}$) with respect to pre-tax income. The full vertical effect is based on the comparison of $\mathbf{L_X}$ with $\mathbf{K_C}$. Its index measure is given by the difference between the Gini coefficient of pre-tax income and the concentration coefficient of the counterfactual income. Type 2 horizontal effect is based on the comparison of K_C and K_Y. The corresponding summary index is equal to the concentration coefficient of post-tax income minus the concentration coefficient of counterfactual income. As noted in footnote 18, the overall or APK ranking effect is based on K_Y and L_Y. Hence, the redistributive effect is equal to the full vertical effect, minus type 2 horizontal effect, minus APK reranking[19]. Formally, we write: $RE = V^* - H^* - R^{APK}$.

In closing this discussion of measurement issues, we would like to point out that the progressivity of indirect taxes can also be assessed on the basis of the price elasticity of poverty measures (e.g Watts or members of the Foster-Greer-Thorbecke family). In this framework, the impact of taxes on individual welfare is calculated with the help of an indirect utility function. This is the maximum level of utility attainable given a budget

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summarized by the difference between the Gini coefficient of post-tax income and the concentration coefficient of ordering 1. Now define ordering 3 as the situation where income units within group are ranked by post-tax income level while groups are ranked by pre-tax mean. Compute the concentration of post-tax income associated with this ordering. Within group reranking is based on the comparison of the concentration curve of ordering 1 with that of ordering 3. Its summary index is equal to concentration index 3 minus concentration index 1. Now unscramble ordering 3 by lining up groups according to their post-tax means, *ceteris paribus*. Call this ordering 4, and compute the associated concentration curve of post-tax income. Entire group reranking is determined by the comparison of concentration curve 3 and 4 and can be summarized by concentration index 4 minus concentration index 3. Finally, AJL reranking is based on the comparison of concentration curve 4 with the Lorenz curve of post-tax income. The associated summary index is equal to the Gini coefficient of post-tax income minus concentration index 4.

[19] Urban and Lambert also show that the full vertical effect is equal to the AJL vertical effect plus entire group reranking. Type 2 horizontal effect is equal to AJL horizontal effect minus within group reranking.

and the prevailing prices. The approach also relies on the elasticity interpretation of budget shares. Under certain conditions, it can be shown that when the price of a commodity increases by one percent, say, real income declines by an amount equal to the corresponding budget share (Deaton and Muellbauer 1980). This is the variable that links changes in individual welfare due to tax induced price changes to changes in poverty. Hence the progressivity of a given indirect tax hinges critically on the variation of budget share as expenditure increases. A basic conclusion that emerges from this approach is that a progressive commodity tax imposes a higher burden on high-income households by placing a higher tax rate on commodities that constitute a higher proportion of the budget of these households. The reader interested in more details about this methodology is referred to Essama-Nssah (2007) or Bibi and Duclos (2007).

Incentive Properties and Welfare Cost

As noted earlier, socioeconomic agents can change their behavior in response to taxation subject to institutional constraints. This distortion of economic behavior response underlies tax shifting and can cause significant welfare loss[20]. This is easily understood in the context of the *first fundamental theorem of welfare economics* establishing the Pareto optimality of the competitive equilibrium (Salanié 2003). In a pre-tax equilibrium, optimal decisions taken by consumers lead the equality between marginal rates of substitution and relevant relative prices. Similarly, on the supply side, firms equate marginal rates of technical substitution to relative prices. Taxation introduces distortions to the extent that it leads various agents to perceive different relative prices. Consumers may be looking at tax-inclusive prices while the producers are looking at pre-tax prices. This divergence in signals received by both sides of the market induces a misallocation of resources which carries with it a welfare loss (beyond the tax revenue collected) known as *deadweight loss* or *excess burden* of taxation. It is important to note that deadweight loss would occur even if the revenue collected were to be returned to the consumers.

[20] A tax reform can be evaluated on the basis of the marginal social cost of available options for raising revenue. The marginal cost of funds is equal to the fall in social welfare per unit of revenue raised (Stern 1987). In the context of indirect taxes, if the marginal social cost of taxing commodity j is less than the social cost of taxing commodity k, it would be desirable, other things being equal, to increase the tax on j and reduce the one on k by the same amount.

It is instructive and useful to consider the effect of taxes on work effort. Indeed, the evaluation of the impact of a welfare-to-work policy requires a careful consideration of the labor supply decisions of both those individuals who are currently working and those who may be induced to enter the market by the reform. This entails an understanding of changes in wages, participation and hours of work. Labor supply models attempt to explain changes in *participation* and *working hours*. Such changes are linked to variation in the structure of real wages and to reforms in the tax and benefit system.

Standard labor supply models are framed within the logic of individual choice between consumption goods and leisure. This framework helps one establish the determinants of labor supply. It is usually assumed that more of both consumption and leisure is preferred to less. There are two basic income sources: activity within and without the labor market. Given a wage rate and non-wage income, the consumer is assumed to maximize utility (a function of consumption and leisure) subject to the full income constraint based on time endowment. In this context, the wage is viewed both as a price and the opportunity cost of leisure. A change in the wage rate has both an income and substitution effects. For instance, taxing wage income reduces the after-tax wage rate. This will induce the taxpayer to choose more leisure and less work. This is the *substitution effect*. At the same time the tax reduces the level of disposable income so that the worker may want to work more to make up for the loss. This is the *income effect*. The combination of these two effects determines individual labor supply.

A tax on labor may also affect an individual decision to participate in the labor market or not. The determining factor here is the *reservation wage*. It depends on the marginal rate of substitution between consumption and leisure and determines the conditions of participation in the labor market (Cahuc and Zylberberg 2004). Salanié (2003) analyzes a simple situation where an individual faces the choice between not working and working a conventional number of hours (e.g. full time). He shows that taxation reduces the incentive to participate if and only if the marginal utility of income has an elasticity less than one.

The existence of incentive effects associated with taxation implies that the pursuit of equity through taxation comes with a cost in the form of deadweight loss that must be taken into account when evaluating the distributive effect of taxes. This requires an evaluation criterion that combines both efficiency and equity concerns. The generalized Lorenz curve is such a criterion. It is obtained by multiplying the ordinary Lorenz curve by the mean of the distribution. One can also resort to an abbreviated social evaluation function defined as the mean of the distribution times one minus an index of relative inequality (e.g. Gini or Atkison). Given that positive taxation can only reduce social welfare if we do not account for the redistribution of the proceeds, in what sense then is a progressive tax socially desirable? For sure, it reduces inequality. But this does not mean welfare improvement. Lambert (2001) explains that a progressive income tax is socially desirable relative to an equal-yield flat tax because it reduces social welfare less than the latter if both apply to the same pre-tax incomes.

2.3. Ability of a Tax System to Redistribute Wealth and Income

As noted earlier, the basic function of a tax system is to raise revenue to fund government activities. Given that equity is also an important development objective, it is useful to consider the extent to which taxes are able to affect the distribution of income and wealth. We also examine here tax provisions designed to reduce the tax burden on poor people. It is evident that the answers to these questions depend on the instruments used.

Zolt (2008) notes that a progressive tax system transfers to the state a proportion of a taxpayer's net increase in wealth (i.e. income) that otherwise would have been spent or saved. Thus individual income and wealth taxes are the instruments most capable of redistributing income. The effectiveness of the corporate income tax depends on the prevailing shifting pattern. Generally speaking, the factors determining the progressivity of an income tax system include: the top marginal tax rate, the base, the number of deductions and the compliance rate. A system with moderate top rates (i.e. around 30 percent), a broad tax base, few deductions and high compliance rates is likely to be more progressive than one with high top personal rates (around 50 percent), a narrow base, many exemptions and high degree of tax evasion.

To address poverty issues directly, the individual income tax system can be integrated into the social welfare program to provide cash transfers to low-income individuals. However, it is important to take account of the relative efficiency and feasibility of using the income tax this way as the administrative cost is bound to increase. Policymakers can also adopt provisions to reduce the tax burden on the poor. One possibility is to set a high threshold relative to the poverty line to exempt poor people from income tax. This is reflected by a tax structure with a tax-free threshold below which the tax rate is zero. Such a threshold must be chosen carefully as it can distort incentives for earning income above it. The jump from a tax-free threshold to the first taxable income band can lead to a marginal tax rate that is so high to discourage the people involved from earning the additional income[21].

There are institutional weaknesses that limit significantly the progressivity of income tax in developing countries. First of all, many potentially taxable transactions take place in a sizable informal sector of the economy. Thus revenues for income tax represent about 2 percent of GDP in developing countries compared with 11 percent of GDP in developed countries (Zolt 2008). Second, a weak tax administration combined with the ability of residents to shift assets outside the country limits the collection of income tax on formal sector wage income only.

The above limitations of income tax have forced developing countries to rely more on indirect taxes on goods and non-factor services (such as sales, excise and value added taxes). But taxes on consumption tend to be regressive due to the fact that poor people generally spend a higher proportion of their income than non-poor. There are ways of reducing the regressive character of these taxes. In the case of a VAT for instance, the authorities could lower the tax rate (including complete exemption) on a handful of basic foodstuffs such as rice and cooking oil. The use of broad commodity groups such as food would not do since households at all income levels consume these commodities. One standard recommendation is to tax heavily certain luxury goods that are most likely consumed by high income households. Creedy (2001) notes this approach

[21] This is particularly the case if earning additional income implies a reduction in transfer payments or other forms of social assistance. This would amplify the jump. Relief can also be provided to low-income people through special deductions or credits designed to reduce the after-tax costs of certain categories of expenditures such as, education, medical or job training expenses (Zolt 2008).

is not likely to produce much revenue let alone affect the distribution of income in view of the fact that high-income households are more able to substitute away from commodities that are highly taxed. Furthermore, differentiation by narrow commodity groups or brand name entails administrative costs.

The above considerations reveal the difficulties associated with using the tax system in developing countries to redistribute income and wealth. They also point to desirable properties of a tax system in terms of breadth of the base, level of rates, number of exemptions and administrative capabilities.

3. Incidence of Public Expenditure

Analyzing the incidence of public expenditure is analogous to tax incidence analysis. The key questions under consideration are the following: (1) Who benefits from public expenditure and by how much? (2) Is the implied distribution of benefits socially desirable? (3) What is the welfare impact of public spending? This section reviews the current practice in answering the above questions. It starts with the basic approach to benefit incidence analysis which provides a profile of the distribution of benefits from an expenditure program along the distribution of some indicator of the living standard (i.e. income or consumption). If the distribution of benefits is *regressive*, then the expenditure program reduces inequality[22]. We next review some simple approaches designed to account for behavioral responses to public spending. These behavioral responses ultimately determine the distributional outcome of the expenditure program and its welfare impact. Finally we note the need for assessing the combined incidence of taxation and public expenditure.

[22] Recall that an income tax is progressive if higher income brackets pay a higher proportion of their income in taxes. In other words, the ratio of tax to income is an increasing function of income. Given that benefits from public expenditure are added to income (and not subtracted as taxes), an expenditure program is progressive if the ratio of benefits to income is a decreasing function of income. That is benefits are regressively distributed (Lambert 2001).

3.1. Standard Benefit Incidence Analysis

Valuation Issues

The estimation of the benefits derived from public expenditure is fraught with serious *valuation issues*. Public expenditure can take the form of cash transfers, subsidies or direct provision (by the state) of goods and services. While it may be easier to measure cash transfers to households or individuals it is very difficult to measure the benefits accruing to individuals or households from publicly provided goods and services. The market system provides a convenient way of valuing private goods sold on the market. This convenience stems from the fact that the price of a good or service reflects the marginal benefit to the consumer. In general this approach does not work in the case of public goods because their supply is either rationed or does not adjust to demand. Under these circumstances, whatever price is charged (e.g. user fee) cannot signal marginal benefit or the willingness to pay (Martinez-Vazquez 2008). The solution adopted in the context of benefit incidence analysis is to value benefits from an expenditure program on the basis of the *unit cost* of provision.

A number of practical decisions must be made in estimating unit cost. These issues relate particularly to the treatment of capital expenditure and of cost recovery. Most estimates are based on current expenditure. However, Demery (2003) explains that if capital spending is to be included in the calculations, this must be done only through the value of the services flowing from this capital. With respect to cost recovery, he suggests that only fees that are returned directly to the treasury must be netted out of gross spending. Fees that are retained by the service providers such as schools or clinics should not be subtracted from gross spending because presumably they are used to improve the quality of the service.

To obtain a distribution of the benefit from public spending, one combines information on the *cost* of provision with data on the *use* of the relevant public goods and services. Thus the analysis can be applied only to assignable public expenditure (Demery 2003), that is expenditure for which beneficiaries can be identified. This poses a serious problem because most public goods are non-rival to the extent that every unit can be enjoyed fully by all people. In view of this fact, benefit incidence analysis is usually applied to a limited subset of public expenditure programs, mainly in education, health and infrastructure.

Method

The construction of the distribution of benefits associated with a particular public expenditure program involves the following three basic steps: (1) using data from public expenditure accounts and the operation of the program under study, estimate the unit cost or subsidy associated with the public service in question; (2) from household survey data, estimate the rate of use[23] of the service by each household and impute the benefits on the basis of these estimates; (3) report the results by policy-relevant socioeconomic groups (e.g. by quantiles of the distribution of some welfare indicator, or by region, gender or ethnic groups).

To see some of the computations involved, we consider the case of public education as explained by Demery (2003). Let **j=1, 2, …, m** represent policy-relevant socioeconomic groups. Let **i=1,2,3** stand for the usual three levels of education, primary, secondary and tertiary. Furthermore, let $\mathbf{R_i}$ represent the total public school enrollment at level **i**, and $\mathbf{R_{ij}}$ the enrollment from group **j**. Finally, let **S** and $\mathbf{S_i}$ stand respectively for total government subsidy and the amount of subsidies going to level **i**. The total amount of the public education subsidy imputed to group **j** , $\mathbf{B_j}$, can be formally written as:

$$B_j \equiv \sum_{i=1}^{3} R_{ij}\,\frac{S_i}{R_i} \equiv \sum_{i=1}^{3} \frac{R_{ij}}{R_j} S_i \tag{3.1}$$

Expression (3.1) is written in a way that clearly shows that the benefit incidence of education spending allocated to group **j** for each level of education is equal to the enrollment of the group at that level of education times the unit cost. The expression can also be normalized by **S** to yield the share of the total education spending imputed to group **j**, $\mathbf{b_j}$. The result can be written as follows:

$$b_j \equiv \sum_{i=1}^{3} \frac{R_{ij}}{R_i}\left(\frac{S_i}{S}\right) = \sum_{i=1}^{3} r_{ij} s_i \tag{3.2}$$

[23] In the case of education and health, this information relates to enrollment rates or clinic visits reported by members of a household.

In the above expression (3.2), $\mathbf{r_{ij}}$ stands for the share of group **j** in total enrollments at level **i**, while $\mathbf{s_i}$ represents the share of total of public spending on education going to level **i**.

One interesting approach to incidence analysis does not require an estimate of a unit subsidy. It notes only whether or not a service is used by a household. One can then define a dummy variable that takes the value of one if the service in question is used and zero otherwise. The analysis is thus based on the distribution of this dummy variable across socioeconomic groups.

One way of determining whether or not an expenditure program is progressive is to consider how the share of the benefits relative to the income of the recipients varies across income quantiles. If this share declines as we move from the poorest to the richest quantiles[24], the underlying expenditure program is progressive. Table 3.1 shows an example based on the incidence of public spending on health in Ghana in 1992. According to these results, the underlying spending program is progressive because, for the poorest quintile, the subsidy represents 3.5 percent of total household expenditure compared to 1.8 for the richest quintile (Demery 2003).

Table 3.1 Incidence of Public Spending on Health in Ghana (1992)

Quintile	Per Capita Subsidy (Cedis)	Share of Total Subsidy (%)	Subsidy as Share of Total Household Expenditure
1	2296	12	3.5
2	3065	15	3.1
3	3692	19	2.8
4	4228	21	2.3
5	6515	33	1.8
Ghana	3959	100	2.4

Source: Demery (2003)

In general, one can compare the concentration curve of the imputed benefits with the Lorenz curve of the reference welfare indicator (e.g. income or consumption

[24] Hence the distribution of benefits is regressive.

expenditure) to determine the progressivity of a public expenditure program. If the concentration curve lies everywhere above the Lorenz curve of the welfare indicator, we conclude that the expenditure program is progressive. The associated benefits are more equally distributed than the reference welfare indicator.

It is instructive to examine formally the comparison of concentration curves discussed above. Let $\mathbf{L_X}$ stand for the Lorenz curve of original income. That is before benefits are imputed to income units. Let $\mathbf{K_B}$ and $\mathbf{K_Y}$ stand respectively for the concentration curves for the benefits and for post-benefit income. Lambert (2001) shows that benefits are regressively distributed (meaning that the public expenditure program is progressive) if and only if the concentration curve for benefits dominates that for post-benefit income and the latter dominates the Lorenz curve for original income. That is: $K_B \geq K_Y \geq L_X$.

By definition, the concentration curve for the post-benefit income is a weighted average of the Lorenz curve for original income and the concentration curve for benefits. The weights depend on the *average rate of benefit* (or total benefit ratio) **b**. Formally, we can write: $K_Y \equiv \frac{1}{1+b}L_X + \frac{b}{1+b}K_B$. This definition implies the following relationship between a local measure of the *redistributive effect* and a local measure of *disproportionality*[25].

$$\left(K_Y - L_X\right) = \frac{b}{1+b}\left(K_B - L_X\right) \tag{3.3}$$

The same relation holds between global measures as follows:

$$\left(G_X - C_Y\right) = \frac{b}{1+b}\left(G_X - C_B\right) \tag{3.4}$$

Where **G** and **C** stand respectively for the Gini coefficient and the concentration index. The above two expressions reveal that the redistributive effect of an expenditure program can be decomposed multiplicatively into a *level* and a *disproportionality* component. The redistributive effect of regressive benefits can be enhanced either by scaling up the

[25] The relation can be easily established in three steps: (1) multiply the definition through by (1+b); (2) subtract bL_X from both sides of the result; (3) shift L_X from the right to the left hand side, factor out appropriate terms and normalize the result by (1+b).

benefits or by redistributing a given total of benefits more in favor of the poor (Lambert 2001). This is analogous to the case of a progressive income tax.

The extent to which the expenditure program is *targeted* to the poor can be judged on the basis of the comparison of the concentration curve for benefits with the line of equal distribution (the 45 degree line). The further the concentration curve lies above the 45 degree line, the better the targeting. In this case[26], the poorest 100**p** percent of the population receives more than 100**p** percent of the total subsidies. Targeting is weaker when the concentration curve of the benefits lies below the 45 degree line. The results presented in table 3.1 reveal that the poorest received 12 percent of overall public health spending compared to 33 percent for the richest. This is an indication of poor targeting of public health spending in Ghana in 1992.

Table 3.2. Incidence of Primary and Secondary Public Education Expenditure in Malawi (1997/98)

	1st Quintile	2nd Quintile	3rd Quintile	4th Quintile	5th Quintile
			Incidence		
Primary	25	23	19	18	14
Secondary	18	19	22	20	21
			Share of School-Age Population		
Primary	24	22	20	18	16
Secondary	24	21	20	19	16

Sourec Al-Samarrai and Zaman (2007)

Another important way of assessing the equity of a spending program is to compare benefits received to needs. Comparing the distribution of benefits to that of household income or expenditure does not tell the whole story as there could be significant differences in needs across income levels. This point is well illustrated by the case on primary and secondary public education spending in Malawi presented in table 3.2 (Al-Samarrai and Zaman 2007). The results of this incidence analysis show that the poorest quintile has the greatest demand for both primary and secondary education. Their share of the school-age population in both education sectors is higher than that of any other income group. When compared specifically with the richest quintile, the

[26] The associated concentration curve is concave and the corresponding concentration index is negative.

information presented in table 3.2 reveals that public spending on primary education is pro-poor. The share of the subsidies going to the poorest quintile is slightly higher than their share of the school-age population. But, the incidence of public spending on secondary education favors the non-poor. The poorest quintile, with 24 percent of the school-age population receives only 18 percent of the subsidy for secondary education. The richest captures 21 percent of the subsidy with only 16 percent of school-age population.

Determining Factors

Benefit incidence analysis can help identify who benefits from public services by combining information on unit costs of provision with data on the pattern of use of these services by households. To draw proper policy implications from this type of analysis, it is important to understand what drives the observed distribution of benefits. For sure there are supply and demand factors involved here. The choice of the welfare indicator also plays a determining role. In the case of social services (health and education), one important supply factor to consider is the allocation of public spending across sub-sectors (i.e. primary, secondary and tertiary). Castro-Leal et al. (1999) study the effectiveness of public spending on social services in several African countries. In general, they find that these services are not targeted to the poor. One important reason they note is the allocation of public spending to different levels of service. For instance, they find that significant shares of health budgets go to hospital based services, which are rarely used by the poor. Thus, the composition of expenditure is a key determinant of its effect on different socioeconomic groups.

Demand interacts with supply to determine the targeting outcome for public spending. The demand for public services is influenced by such factors as *income*, *quality* and *costs* (both opportunity and direct costs). The study of public spending on social services in Africa by Castro-Leal et al. (1999) found that household spending on health and education increases with income. They conclude that the demand for these services increases with income. Thus one way of improving the targeting of these services to the poor is to divert to the private sector the demand by the better-off.

Table 3.3. Incidence of Public Spending on Education is South Africa in 1994

	Share of Primary Subsidy		Share of Education Subsidy	
Quintile	Disaggregated Unit Cost	Average Unit Cost	Disaggregated Unit Cost	Average Unit Cost
1	18.9	25.8	14.1	19.9
2	17.7	23.3	15.4	20.7
3	16.5	19.7	16.0	19.7
4	19.1	17.8	19.6	19.1
5	27.8	13.5	34.9	20.3

Source: Castro-Leal (1996) as cited by Demery (2000)

The demand for public services is also sensitive to the *quality* of those services. The quality of health services depends on such things as drug availability, staff skills and the general upkeep of the facilities. Castro-Leal et al. (1999) suggest that unit cost variations among socioeconomic groups can be considered a proxy for variations in the quality of the provided service. They cite the case of South Africa under the apartheid regime where the pupil-teacher ratio in black schools was more than twice that in white schools. These unit cost variations reveal indeed a greater degree of inequality both in the distribution of public resources and that of welfare outcomes than would an incidence analysis based on national average cost.

This point is well illustrated, again with data from South Africa. Table 3.3 presents results from an analysis of public expenditure on education in South Africa based on two different estimates of unit cost. One is race-specific while the other is an average across races. The results based on the mean unit subsidy are misleading. They would lead one to believe that in 1994, the poorest quintile got about 26 percent of the total subsidy for primary education versus 14 percent for the richest. For the overall education subsidy, the use of the mean unit subsidy implies that each quintile received more or less it proportionate share of public spending on education. Race-specific unit subsidies tell a different story. For primary education, the results based on this measure reveal that the poorest quintile got 19 percent of the subsidy compared to 28 percent going to the richest. For overall spending on public education, calculations based on race-specific unit cost show that the poorest quintile got about 14 percent of the subsidy compared with 35 percent for the richest.

There are *costs* associated with the use of public services, even for services that are provided free of charge to the household. Some of these are transaction costs to the extent that they must be incurred in order to gain access to the service. These include mainly transportation and the opportunity cost of the time use to get the service (Demery 2000). In addition, one should consider household spending that enhances the benefits obtainable from the publicly provided service. In the case of education, these expenditures would cover such things as books, uniforms, and other school supplies. The total cost of access and use can represent a significant burden[27] for low income households and limit their use of the service. In education such costs have been found to explain non-enrollment or drop-outs. A recent evaluation of the welfare impact of rural electrification by the Independent Evaluation Group (IEG) of the World Bank found that even in villages that have been connected to a national grid for 15 to 20 years, one can still find 20 to 25 percent of households unconnected because they cannot afford the connection fee. A major implication of this state of affairs is that tariff structures designed to be progressive end up being regressive subsidy schemes (World Bank 2008).

Finally, we note that benefit incidence results may be sensitive to the choice of the *welfare measure*. As noted earlier, accounting for need differences across income levels can reveal more inequality than standard benefit incidence analysis would. Demery (2000) explains that such demographic differences across quintile are partly due to the use of per capita total expenditure as the welfare indicator. Such differences may indeed be attenuated or disappear all together if one were to assign individuals to quintiles on the basis of per adult equivalent expenditure. To demonstrate this point, the author cites a benefit incidence study of public education in Ghana (1992). When the population is ranked on the basis of per capita expenditure, it is found that the poorest quintile gets about 22 percent compared with 17 percent when per adult equivalent expenditure is used as the welfare indicator. In contrast, the share of the richest quintile increases from 14 percent to about 18 percent.

[27] The extent of this burden can be assessed on the basis of the affordability ration. In the case of health this ratio compares household spending per visit with its per capita non-food expenditure (Demery 2003).

There is a deeper issue with the choice of a welfare measure given that the underlying concept of living standard is multidimensional. Standard benefit incidence analysis ignores this fact to the extent that it translates all public spending, whether in cash or in-kind, into the equivalent monetary transfer and evaluates the implied changes in the distribution of income (van de Walle 1998). Yet, as noted in the introduction, public policy ultimately seeks to improve people's lives. Thus, in the context of social expenditure for example, we are in fact more interested in knowing whether health status has improved as a result of public spending on health care, or whether spending in education leads to improved literacy and numeracy.

Hammer et al. (1995) recognize this issue in their assessment of the distributional effects of social sector expenditures in Malaysia. In particular, they note that spending on health and education is a productive investment in human capital. This observation led them to broaden their incidence analysis and seek to determine the extent to which the improvement in health and education status in Malaysia between 1974 and 1989 was a result of government policy. Using regression analysis[28], they found that immunization and the provision of safe water had the strongest and most robust effects on health outcomes. They also concluded that public expenditure on primary education significantly improved outcomes.

3.2. Accounting for Behavioral Responses to Public Spending

The interaction of demand and supply factors discussed above suggests that the way individuals react to an expenditure program is crucial in determining both the *welfare* and the *distributional outcome* of such a program. Ignoring behavioral responses to a spending program is bound to introduce some bias in the estimates of the

[28] The analysis for health applies OLS, fixed and random effects models to a panel of state-level data for 1986-1989. The dependent variables are infant and maternal mortality rates. Explanatory variables include: (1) average state income, (2) immunization rate, (3) the proportion of the population with safe water, (4) the number of doctors per capita who are publicly assigned. Educational outcomes are measured by schooling transition rates or repetition rates. In the case of primary school, the dependent variable is the proportion of students in the last year of the primary level who continue on to the lowest grade of the secondary level. The independent variable include: (1) income, (2) public expenditure per student, and (3) the percentage of state income accounted for by agricultural production. According to the authors, this last variable acts as a proxy for the opportunity cost of students' time.

distributional impact of the program in question. In section 4, we will present more elaborate ways of modeling behavior and interaction in the context of fiscal incidence analysis. For now we focus on some basic tools for taking behavioral response into account when analyzing the incidence of public spending. These simple methods rely on reduced form relationships between interventions and outcomes. They do not attempt to bring out all behavioral inter-linkages that may explain the outcome (van de Walle 2003).

There are two situations where behavioral approaches are particularly relevant. The first concerns the construction of a *counterfactual* distribution of welfare against which the impact of a spending program is to be judged. The second situation pertains to the assessment of the distributional implications of a program expansion. This latter case is known as *marginal incidence analysis*.

Fundamentally, the incidence of an expenditure program (or any public policy for that matter) entails a comparison of the distribution of a welfare indicator (such as income) *with* and *without* the given program (or policy). Reliable information on the counterfactual, that is the distribution of welfare that would have prevailed in the absence of the expenditure program, is necessary for an accurate estimation of incidence. A reliable counterfactual is also needed if we are to make any causal inference about the expenditure program for policy purposes. This is due to the fundamental fact the effect of a cause can be understood only in relation to another cause (Holland 1986). The behavioral responses of socioeconomic agents to public policy must therefore be accounted for properly to improve the representation of the state of the world that would have prevailed in the absence of the policy under consideration. Indeed there is evidence that an expenditure program can affect such behavior as savings, labor supply and schooling choices. It can even crowd out private transfers received by households. Behavioral approaches are considered as attempts to resolve the counterfactual problem (van de Walle 1998).

Regression analysis of the type described above in the context of the Malaysia study represents the simplest way of accounting for behavioral responses and hence improving the definition of the counterfactual. One can specify a linear regression model where a welfare indicator is a function of program participation and individual characteristics (both observable and non-observable). To be meaningful, this specification requires a sound understanding of the rules that govern budget allocation and program placement. This understanding is also crucial to deal effectively with the potential problem of *endogeneity* that can confound the causal interpretation of the results[29].

Behavioral approaches are also relevant in the context of marginal incidence analysis which seeks to determine who benefits from the expansion of an expenditure program (or who loses from a cut in public spending). The standard benefit incidence method predicts that people gain or lose in proportion to the benefits they are currently receiving under the program. This might be the case for a policy (e.g. a subsidy) that changes the price of a commodity proportionately. In general, one should not expect the additional benefits from an expanded program to go to current beneficiaries. Even if they do flow to them, it is not necessarily in proportion to their current benefits. Indeed, the socioeconomic composition of participants can change dramatically as the program expands or contracts (Lanjouw and Ravallion 1999).

Several methods have been proposed to deal with this issue. Younger (2003) notes the following three. The first method relies on *spatial variations* in program coverage. The second is based on changes induced by program *expansion over time*. The last approach relies on *econometric analysis* to estimate either compensating variations or changes in the probability of participation. The first method emerged from a study by Lanjouw and Ravallion (1999) of the relationship between program size and the composition of program participation[30]. These authors argue that the distributional

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[29] Endogeneity would arise if the policy variable (this could be a dummy variable indicating program participation) is correlated with unobservable characteristics of the household as represented by the random disturbances in the regression equation. Under these circumstances, the use of standard OLS would lead to a biased and inconsistent estimate of policy impact. This correlation can stem from at least three sources (van de Walle 1998). Placement into the program could be determined in part by the welfare indicator used to measure program performance, for instance assigning a nutrition program on the basis of nutritional status. (This would lead to simultaneity bias). Trouble could also stem from the fact that there is a variable that explains both placement and outcomes, yet this in not included in the model. The existence of regional or community level fixed effects or time varying effects that determine both outcomes and placement illustrates this case. Finally, self-selection can cause endogeneity. Statistical solutions to this problem include the use of panel data and fixed effects models, instrumental variable techniques and randomization.

[30] Lanjouw and Ravallion (1999) explain that program participation is homogeneous of degree one if group-specific participation rates stay the same as the program expands. For instance if 100p percent of the participants are poor when the program operates at level 1 with a given number of participants, then 100p percent of participants are also poor when the program expands to level 2, covering more people. Thus, standard benefit incidence analysis assumes homogeneity. If the poor are able to capture program benefits at certain points in time and not others, then participation is said to be non-homogeneous. This would be

impact of a program expansion hinges on the political process that governs the allocation of program's outlays. In particular, it depends on the ability of different socioeconomic to influence that process.

These political economy considerations led the authors to propose a simple regression model linking, for each quantile, the participation rate for a region within a given state[31] to an instrument for the state's average participation rate. More precisely, quantiles are defined over the entire rural population ranked by total consumption per capita[32] (normalized by state-specific poverty lines). The assessment of marginal program incidence is based on the *marginal odds of participation*. This is the increment in program participation rate of a given quantile associated with a change in aggregate participation[33]. Lanjouw and Ravallion (1999) note that, for a given quantile, variations of its participation rate across regions depend on the size of the program in the state to which each region belongs. The size of the program is measured by the state's average participation rate. This latter variable is instrumented by the so-called "leave-out mean", which is the state average participation rate computed without the participation rates for the specific region and quantile under consideration. Following Younger (2003) the underlying regression model can be written as follows: $p_{r,k,q} = \alpha_q + \beta_q x_k + \varepsilon_q$. The left-hand side is the participation rate for quantile **q** in region **r** of state **k**, and $\mathbf{x_k}$ is the instrumental variable[34]. The coefficient $\boldsymbol{\beta_q}$ measures the *marginal odds of participation* for quantile **q**. Estimates of these coefficients are interpreted as the gain in subsidy

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the case if poor people live in remote areas and the program expands geographically starting with less remote regions.

[31] The authors applied the methodology to rural India taking advantage of large observed differences across Indian states in the size of each program considered namely: (1) a means-tested credit scheme known as the Integrated Rural Development Program (IRDP); (2) the Public Distribution System (PDS) which is a food rationing program; and (3) a public works scheme. There are 62 regions spanning 19 states. The data used are from the 1993-1994 National Sample Survey (NSS).

[32] Ajwad and Wodon (2001) propose a variant of Lanjouw and Ravallion (1999) approach. The basic difference between the two methods lies in the ranking of households in order to create quantiles. Instead of defining quantiles on the basis of the overall distribution of welfare, Ajwad and Wodon would define the relevant quantiles on the basis of distribution of welfare within each state.

[33] The proportion of households in a given quantile that participate in the program is the average participation rate. The average odds ratio of participation, for a given quantile, is equal to its participation rate divided by the overall average participation rate.

[34] Using the state average participation including the region and quantile under consideration would create an endogeneity problem that would lead to biased estimates. Younger (2003) suggests that when possible, one can use panel data on regions to control for regional fixed effects. He also notes that grouping observations into regional and quantile averages entails a loss of efficiency in estimation. He thus recommends the use of individual level data.

incidence per capita for each quintile as a result of a one dollar increase in aggregate program spending (Lanjouw and Ravallion 1999).

The Lanjouw-Ravallion method described above relies on a single cross-sectional data set. It is possible to infer marginal incidence of a program based on simple comparison of incidence at different points in time. This comparison requires the availability of at least repeated cross-sectional data. Take the case of a given level of education for instance and let $\mathbf{R_{qt}}$ be the number of students from quantile **q** enrolled in that level of schooling in year t=1,2. Let $\mathbf{R_t}$ stand for total school enrollment for that level in year t. The changes in incidence over time across quantiles can be looked at in one of the following ways (van de Walle 2003): $MBI_q = \left(\frac{R_{q2}}{R_2} - \frac{R_{q1}}{R_1} \right)$ or $MBI_q = \left(\frac{R_{q2} - R_{q1}}{R_2 - R_1} \right)$.Studies based on the comparison of incidence at different points in time include Hammer, Nabi and Cercone (1995) for Malaysia, and Al-Samarrai and Zaman (2007) for Malawi. In particular, the Malawi study compared the incidence of public expenditure on education (primary and secondary level) between 1990/91 and 1997/98. It was found that, the changes in incidence were pro-poor. The improvement for the primary level of education is attributed to the abolition of fees decided by the government in 1994.

Finally, one can apply discrete choice models[35] to marginal impact analysis by estimating the probability of participation in a program. Participation is assumed to provide the highest level of utility relative to available options. Thus, the estimated probability is viewed as the expected demand for the services provided by the program. In the context of education for instance, the underlying utility is usually taken to be a function of school quality, household and individual characteristics. Estimated probabilities are interpreted as expected enrollment rates. Changes in these probabilities (of participation) induced by program expansion provide a measure of marginal incidence that can be reported by quantile. Alternatively, one can estimate the underlying random utility model to conduct the analysis in terms of changes in compensating variation induced by the policy reform.

[35] Section 4 contains a more detailed discussion of such models.

Younger (2003) applied the three methods outlined above along with the standard benefit incidence approach to estimate the *marginal incidence* of an expansion of secondary schooling in rural Peru[36]. Based on this comparative analysis, he offers the following general characterization of these methods. The standard method also has a marginal interpretation in the case where the policy reform affects only current beneficiaries in proportion to their current benefits. This is the case of homogeneous program participation also noted by Lanjouw and Ravallion (1999)[37]. Method 1 (based on marginal odds of participation) and method 2 (based on changes in incidence over time) assume invariance of the underlying political economy constraints and that these can be captured by the correlation between program size and the implied distribution of benefits. Method three (based on discrete choice) is more behavioral to the extent that it relies directly on utility maximization to model participation and the willingness to pay.

3.3. Incidence of the Net Tax System

The ultimate question of interest in fiscal policy is the net incidence of fiscal policy or the combined incidence of taxes and public spending. After all, taxes are mostly justified on the basis of expenditures that must be covered given an accepted role of government. Furthermore, Lambert (2001) notes that a welfare rationale for taxation can be found only by considering the way public spending affects people's economic well-being. Given the importance of behavior in determining the welfare impact of policy, incidence analysis must account, to the extent feasible, for the interaction between tax and spending policies. Indeed a progressive public spending program can dominate regressive taxation to make the overall impact progressive. This dominance relation can also run the other way around. Martinez-Vazquez (2008) notes for instance that a cost recovery scheme may be deemed regressive, yet if the proceeds are used to finance better health services for the poor, the whole operation will be progressive. However, he adds that the fragmentation of the decision making process for budgetary policymaking

[36] Recall that marginal incidence represents the distribution of benefits (losses) associated with program expansion (contraction).

[37] In the terminology adopted by these authors, the average and marginal odds of participation are equal only when participation is homogeneous.

implies that fiscal incidence analysis is relevant only for the entire government budget (a quite difficult task in view of the information constraints one would face).

Fiscal incidence analysis entails a comparison of the *original income* (without government activity) with *final income* (including taxes, transfers and benefits from spending). The latter is obtained from the former as follows (Hemming and Hewitt 1991). Starting with original private income, allocate taxable cash transfers to obtain the distribution of *total income*. Then subtract direct taxes to get the distribution of *post-tax income*. Based on this distribution, assign indirect taxes, nontaxable cash and in-kind transfers to obtain the distribution of *net income*. The distribution of *final income* is obtained by allocating benefits from public spending by net income classes.

Lambert (2001) shows how to measure the progressivity of the net tax system by considering the associated redistributive effect. To see what is involved, define the net tax schedule simply as: $t_N(x) = t(x) - b(x)$. This is a function of the original income x. The operation of this schedule implies that final income is equal to original income minus taxes plus benefits. If the first order derivative of this schedule is strictly less than one, then the concentration curve for final income is also the Lorenz curve for the same income variable. Denote this by $\mathbf{L_Y}$. By definition $L_Y \equiv \frac{(L_X - gK_T + bK_B)}{(1-g+b)}$, where g and b stand respectively for the total tax ratio and the benefit ratio. The net redistributive effect can therefore be written as:

$$(L_Y - L_X) \equiv \frac{g}{(1-g+b)}(L_X - K_T) + \frac{b}{(1-g+b)}(K_B - L_X) \tag{3.5}$$

In terms of Gini and concentration indices, we have the following decomposition of the Reynolds-Smolensky index of net redistributive effect:

$$(G_X - G_Y) \equiv \frac{g}{(1-g+b)}(C_T - G_X) + \frac{b}{(1-g+b)}(G_X - C_B) \tag{3.6}$$

Expressions (3.5) and (3.6) show how both the distribution of the tax burden and that of benefits determine whether and to what extent final income is shifted from high incomes to low incomes. It can be shown that if the tax burden is distributed progressively while benefits are distributed regressively, the net tax schedule will be progressive (Lambert 2001).

Devarajan and Hossain (1998) offer a good example of net fiscal incidence analysis. They compute, within a general equilibrium framework, the combined incidence of taxes and a group of public expenditures in the Philippines[38]. On the revenue side of the budget, they consider income and business taxes as well as indirect taxes including excise, import tariffs and VAT. On the spending side, they focus on three major categories of expenditure believed to have significant distributional implications. These relate to infrastructure, health and education. These three components of public spending account for about 30 percent of total public expenditure. Their measurement of the incidence of direct taxes is based on the *effective tax rate*. This is defined as tax revenue divided by the base. Due to data limitations, the authors infer the incidence of public spending from regional pattern of expenditures and regional income distributions. The overall incidence of each component of expenditure is computed as a weighted average of the regional incidence where the weights are the regional allocations of these public expenditures[39].

Table 3.4. Net Fiscal Incidence in the Philippines (1998-1989)

Decile	Taxes	Expenditures	Net Incidence
1	20.8	46.9	-26.1
2	20.5	22.2	-1.7
3	20.1	17.5	2.6
4	20.0	14.4	5.6
5	19.8	12.2	7.6
6	19.9	10.2	9.7
7	20.1	8.7	11.4
8	19.7	6.9	12.8
9	19.7	5.1	14.6
10	19.6	0.11	19.5

Source: Devarajan and Hossain (1998)

[38] We consider the structure of their general equilibrium model in the next section. Here, we focus mostly on the findings.

[39] A key assumption underlying this approach is that the benefits from expenditures in any region are distributed uniformly within that region.

The overall results from this study are presented in table 3.4. The share of the tax burden is more or less constant across deciles. This means that the incidence pattern of taxes in neutral. The authors explain that this is due to the fact that indirect taxes are only slightly regressive. The net incidence is progressive due to the pattern of public expenditures. In particular, public expenditures per capita are concentrated in the poorer regions of the country.

4. Modeling Fiscal Incidence

Fundamentally, *fiscal incidence analysis* is an exercise in social impact assessment to the extent that it entails an evaluation of variations in *individual* and *social welfare* attributable to the implementation of fiscal policy. This type of evaluation requires a social policy model that clearly links policy instruments to social outcomes. The modeling framework which organizes our discussion in this section relies on the basic view that the distribution of economic welfare in a given society depends critically on individual behavior and endowments, and the socio-political arrangements that govern social interaction. Once the observed outcomes are explained, their social desirability is assessed on the basis of an evaluation function summarizing the value judgments presiding over the evaluation. We can therefore think of a social policy model as having two components, a *positive* one that explains outcomes and a *normative* one that rank them socially. We review both the microsimulation and the general equilibrium approaches to fiscal incidence modeling.

4.1. Microsimulation Models

Overview

What is a *microsimulation model*? A microsimulation model is a logical representation of the *behavior* of individual agents and their socioeconomic *environment* used to *simulate* the consequences of a policy reform on the level of activity or welfare for each individual in a representative sample of the whole population. Three basic inputs are required for building and running a microsimulation model (Bourguignon and

Spadaro 2006): (1) a micro-dataset containing information on observed economic and socio-demographic characteristics of individuals or households; (2) the policy rules to be evaluated; (3) a theoretical model of individual response to policy.

Standard economic analysis relies on the optimization principle and the market system to explain individual behavior and social interaction. Each agent attempts to implement the best feasible course of action. Modeling optimizing behavior thus entails the specification of (1) actions that a socioeconomic unit can take, (2) the constraints it faces, and (3) the objective function used to evaluate such actions (Varian 1984).

Two basic approaches, both relying on the optimization principle, are commonly used to construct microsimulation models. The first represents optimal behavior by an *envelope function* also known as the maximum value function (Dixit 1990). This is the maximum attainable value of the objective function given the prevailing constraints. The second approach is based on *discrete choice models*. These models seek to explain the behavioral process that leads to the choice made by an agent facing a discrete choice set[40] (Train 2003). The behavioral process is represented by a function linking the agent's choice to observed and unobserved factors. The unobserved terms are taken to be random variables. This randomness implies that the analysis must be conducted in terms of the probability of choosing an option from the choice set.

The usefulness of the microsimulation approach to policy evaluation is better appreciated when compared with the alternative based on representative agents. For instance policy analysis based on two representative households such as rural and urban or even on six or ten regional groups can hide much of heterogeneity in agent's behavior that explains variation in outcomes. The fact that the microsimulation approach uses a micro-data set offers the possibility to fully account for the observed heterogeneity of socioeconomic agents (Bourguignon and Spadaro 2006). Thus the approach provides a more precise way of identifying likely winners and losers from a policy reform. It also improves the accuracy in evaluating the impact of a policy on the government budget. We now consider the use of microsimulation models in fiscal incidence analysis.

[40] A choice set is said to be discrete if it contains a finite number of all possible alternatives that are also mutually exclusive from the point of view of the decision maker (Train 2003). When a choice set contains all possible alternatives, we say that the set is exhaustive.

The Envelope Model

Under the standard assumption that the consumer has an exogenous budget, **y**, to spend on a set of commodities at fixed prices within a period of time[41], indirect utility is the maximum attainable utility given the outlay and the prevailing prices. This function can be formally written as: $v(y, p) = \max_q [u(q);\ p \cdot q = y]$, where **q** is an m-dimensional vector of quantities of commodities and **p** the corresponding vector of consumer prices. As noted earlier, the corresponding cost function is the minimum expenditure required to achieve a given level of utility at given prices. The indirect utility function shows the possible channels of transmission of policy impact to individual welfare. Any policy changing prices or disposable income would affect individual welfare through changes in the budget constraint. The budget constraint therefore can be thought of as a parameterized representation of the socioeconomic environment which mediates the effect of policy on welfare.

The simulation of the welfare impact of policy relies on the *envelope theorem* (hence the name of the approach). In the context of a parameterized optimization problem (as the one described above), the envelope theorem shows how to compute the impact of a parametric change on the objective function at the optimum. According to the theorem, the change in the objective function induced by a change in a parameter while the choice variable adjusts optimally is equal to the partial derivative of the optimal value of the objective function with respect to the parameter (Varian 1984).

In the particular case of fiscal policy, the welfare gain or loss from a marginal change in income tax is equal to the following: $\Delta v = v_y \Delta y$ where $\upsilon_{\mathbf{y}}$ is the marginal utility of income. This change in welfare can be expressed in terms of an equivalent variation in income as (Bourguignon and Spadaro 2006): $\Delta y^* = \Delta v / v_y$. The marginal utility of income is unobservable. Its value must therefore be chosen on some normative basis.

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[41] In other words, the consumer is facing a linear budget constraint. The institutional underpinning of this assumption consists of efficient markets with negligible transaction costs (Deaton and Muellbauer 1980)

The first-order welfare impacts of a marginal reform of indirect taxes can be computed similarly. According to Roy's identity (a manifestation of the envelope theorem), the Marshallian demand function of a commodity is equal to the negative of the first-order derivative of the indirect utility function with respect to the commodity price, divided by the marginal utility of income. Thus, the welfare impact of price changes induced by a tax reform is equal to: $\Delta v = -v_y \sum_{k=1}^{m} q_k \Delta p_k$. In terms of equivalent variation in income, we have: $\Delta y^* = -\sum_{k=1}^{m} q_k \Delta p_k$. In other words, an increase in an indirect tax rate on commodity **k** induces a price change that leads to a loss in real disposable equal to the change in price times the observed level of consumption.

These equivalent variations in income can then be used to estimate the changes in the original income distribution induced by a fiscal policy reform. Incidence analysis can then proceed along the lines discussed earlier. As noted in section two above, one can also assess the progressivity of an indirect tax system on the basis of the price elasticity of a poverty measure. In particular, a price increase (reduction) for a given commodity is considered pro-poor if it causes an absolute increase (reduction) in poverty smaller (greater) than a benchmark case. By analogy to the Lorenz framework, one can choose as benchmark, a situation where everybody assigns the same proportion of real income to the purchase of the commodity in question. The ratio of the observed poverty elasticity to the benchmark case is an indicator of pro-poorness or a measure of the distributional characteristics for the given commodity (Essama-Nssah 2007). If this indicator is less than one, an increase in the price of the commodity would hurt the poor less than the non-poor. This can be used in an ex ante assessment of indirect tax policy options.

Table 4.1 contains results from an application of this method to data for Guinea. They are estimates of the distributional characteristics for 19 components of food expenditure based on the Watts index of poverty and two measures from the Foster-Greer-Thorbecke (FGT) family, the poverty gap and the squared poverty gap. On the basis of these results, there are 11 food items or groups that might deserve special consideration in the context of marginal commodity tax reform. These include palm oil, smoked fish, rice (both local and imported), sugar, cereals, roots, grains, vegetables, oils and sweets. The commodities for which the measure of pro-poorness is greater than one are those with higher budget shares for low-income households. Of the 11 food items identified, cereals, roots and grains have the highest value for the indicator.

The envelope approach to policy impact analysis has some limitations because one can only capture the static effects of the policy reform. Furthermore, the fact that the envelope theorem is valid only in the neighborhood of the initial optimum makes the method inappropriate for the study of large price changes or in situations in which the household is out of equilibrium due to restrictions such as rationing. These cases require an estimation of complete demand and supply systems.

Table 4.1. Guinea (1994): Distributional Characteristics of Components of Food Expenditure

	Poverty Gap	Squared Poverty Gap	Watts
Beef	0.65	0.56	0.61
Palm Oil	1.22	1.16	1.19
Bread	0.78	0.72	0.75
Fresh Fish	0.53	0.45	0.49
Smoked Fish	1.10	1.14	1.12
Local Rice	1.33	1.30	1.30
Imported Rice	1.17	1.23	1.30
Sugar	1.10	1.07	1.09
Cereals	1.57	1.57	1.57
Roots	1.53	1.56	1.55
Grains	1.56	1.61	1.59
Fruits	0.99	0.91	0.95
Vegetables	1.26	1.28	1.28
Meats	0.83	0.76	0.79
Livestock	0.94	0.95	0.95
Beverages	0.57	0.47	0.52
Oils	1.14	1.08	1.10
Sweets	1.04	1.01	1.03
Canned Food	0.42	0.37	0.40

Source : Essama-Nssah(2007)

Discrete Choice Methods

A discrete choice model can be characterized in terms of two fundamental elements: the *choice set* and the *decision process* (or the decision rule). As noted earlier, the choice set must be discrete and exhaustive, and the included options must be mutually exclusive. In the case of discrete models of labor supply, for instance, the choice set can be represented by a few options such as not working, working part-time and working full time. Just as in the case of the envelope model, the decision process assumes utility-maximizing behavior. The decision maker is thus assumed to choose the alternative that provides the greatest utility.

Since utility is not observed by the analyst, the decision process is usually framed with the logic of random utility models. In that framework, utility has two parts. The first, known as the *representative utility* (Train 2003), is a function of some observable characteristics of the decision maker and of the alternatives. The second component is a set of non-observable random factors. Formally, the utility function is written as: $U_{hj} = V_{hj} + \varepsilon_{hj}$, where **h** represents the decision maker, **j** the alternative, **V** the representative utility and **ε**, the random factors. The decision maker would choose alternative **j** if and only if $U_{hj} > U_{hi} \; \forall i \neq j$. Alternatively, this condition can be stated as, **j** is chosen if and only if the following holds $(\varepsilon_{hi} - \varepsilon_{hj}) < (V_{hj} - V_{hi}) \quad \forall i \neq j$.

Because of the uncertainty involved, we can only make probabilistic statements about the decision maker's choice. The probability that option **j** is chosen by agent **h** is defined as follows[42]:

$$P_{hj} = \Pr\{(\varepsilon_{hi} - \varepsilon_{hj}) < (V_{hj} - V_{hi}) \quad \forall i \neq j\} \tag{3.7}$$

The type of discrete choice model derived from the above probability statement is determined by the assumptions made about the distribution of the unobserved portion of the utility function. For instance, the common logit model assumes that the random factors are independently and identically distributed (iid) extreme value variables for all options. In other words, each choice is independent from the others[43].

Bourguignon and Spadaro (2006) explain the use of discrete choice models in ex ante analysis of the incidence of tax-benefit reforms on labor supply. They describe a general framework where the utility associated with an option is a function of some

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[42] The expression of this probability can be made more precise by considering an indicator function of the representative utility and unobserved factors. The indicator is equal to 1 when option j is chosen and 0 otherwise. The probability that the agent chooses option **j** is then equal to the expected value of this indicator function over all possible values of the unobserved factors (Train 2003).

[43] The generalized extreme value model (GEV) allows correlation among unobserved factors. The standard multinomial logit assumes that the random factors are iid with a double exponential distribution. The probit model assumes that the random factors are jointly distributed normal variables. Train (2003) points out that the identification of discrete choice models relies heavily of the fact that only differences in utility matter and the scale of utility is irrelevant.

observed attributes of the agent, the wage rate, the disposable income and some unobserved factors which they refer to as *idiosyncratic* terms[44]. Disposable income depends on labor and non-labor income and the structure of the net tax system. In this framework, tax-benefit reforms affect economic agents' budget constraints by changing their disposable income. The associated income effects combined with the substitution effect due to changes in after-tax wage rates induce a labor supply response.

An important methodological consideration in the probabilistic modeling framework described here concerns the proper way of conducting distributional analysis. *The simulation of a policy reform produces for each individual in the sample, not a chosen option, but a probability distribution over the discrete alternatives listed in the choice set.* In the case of labor supply for instance, a simulation does not indicate the level of hours worked, but a probability distribution over the discrete hours in the choice set. To trace the distributional implications in terms of changes in real income one can simply compute the expected income for each individual over all possible outcomes. The computation is based on the net income associated with each level of hours contained in the choice set. Buddelmeyer, Creedy and Kalb (2007) explain that this approach would understate the true variability of income in the population. They propose alternative approaches that seem computationally challenging.

As noted earlier in section 3, there are situations where probabilities estimated from a discrete choice model can be interpreted as expected demand for a service and distributional impact analysis can proceed mainly on the basis of these probabilities. Glick and Sahn (2006) estimate a discrete choice model of primary schooling for rural Madagascar and evaluate several policy options on the basis of their distributional impact, and of cost to the government. We briefly review their methodology and findings.

Parents with primary school-age children face three basic alternatives: no schooling, enrollment in public school, and enrollment in private school. These parents are assumed to derive utility from the human capital of their children and from the

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[44] These idiosyncratic terms represent unobserved heterogeneity in agents' behavior. They nay explain response heterogeneity for agents who are observationally equivalent. Their estimates are pseudo-residual from the econometric estimation. For policy simulation this terms must be estimated in such a way that predicted behavior coincide with observed behavior.

consumption of other goods and services. The representative utility is modeled as a function of school quality, individual and household characteristics, household income and the cost to the household of choosing a given schooling option[45]. A GEV specification is adopted for the random component of utility leading to a *nested multinomial logit model* to allow correlation among error terms across alternatives. The estimated probabilities of choosing a schooling option are interpreted as demand functions or expected enrollment and provide the basic inputs for distributional impact analysis.

Glick and Sahn simulate the effects on primary school enrollment of the following policy options: (1) add teachers to schools to reduce multigrade teaching by 50 percent; (2) option 1 combined with an increase in public fees of 200 FMG (*Franc Malgache*, the local currency); (3) school consolidation leading to eliminate multigrade teaching. Multigrade teaching is a widespread practice in Madagascar whereby a teacher must handle every teaching day two or more classes. Consolidation entails closing some small rural schools and using the cost savings to improve the quality of nearby schools.

The progressivity of each policy option is assessed on the basis of changes in the distribution of expected enrollment across expenditure quantiles. Two specific criteria are used in this evaluation. The first compares average benefit (i.e. enrollment) across quantiles before and after policy implementation. The average benefit for each quantile is equal to the ratio of its share in overall enrollment to its share of primary school age population. Let **R** and **N** stand respectively for overall primary school enrollment and the total population of primary school age children. The corresponding variables for a given quantile q are respectively $\mathbf{R_q}$ and $\mathbf{N_q}$. The average enrollment in quantile q is defined as $A_q = \dfrac{R_q / R}{N_q / N}$. This can also be expressed as the ration of the quantile-specific enrollment rate to the overall enrollment rate. The second criterion involves normalized or relative marginal shares defined as: $M_q = \dfrac{\Delta R_q / \Delta R}{N_q / N}$.

[45] In the empirical specification is a linear equation where both the income and cost variables are made to interact with a dummy variable indicating the quintile of per capita expenditure to which the household belongs. In this way, the model can capture separate price responses per quintile.

Table 4.2 presents estimated distributions of expected enrollments associated with three education policy options. The first option entails a reduction in multigrade teaching through the provision of additional teachers. Glick and Sahn estimated that a 50 percent reduction in multigrade teaching could be achieved by adding on average one teacher to each school currently using this method. The results associated with this policy option indicate that it would be progressive to the extent that the increase in primary enrollment rate is larger for the bottom 3 quintiles than for the top two. Specifically, relative marginal shares indicate that both the second and third quintiles' share of the increase in the enrollment induced by the policy is proportionately 13 percent higher than their shares of the rural primary school age population.

Table 4.2. Distributional Impact of Education Policy Options in Madagascar

Quintile	Baseline Average Benefits	Policy 1		Policy 2		Policy 3	
		A_q	M_q	A_q	M_q	A_q	M_q
1	0.77	0.78	0.97	0.76	0.38	0.78	0.87
2	1.01	1.02	1.13	1.00	0.46	1.01	1.09
3	0.98	0.99	1.13	1.00	1.69	0.99	1.13
4	1.18	1.16	0.88	1.19	1.62	1.17	1.04
5	1.38	1.34	0.69	1.38	1.23	1.35	0.78
All	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Source: Glick and Sahn (2006)

For policy option 2 that combines option one with an increase in school fees, the results show that lower quintiles would lose while the top ones would gain in terms of changes in enrollments. The bottom two quintiles would get respectively from new enrollments 0.38 and .46 of their school age population shares. Adding cost recovery to option 1 risks to reverse the progressive nature of multigrade reduction[46]. The authors of the study suggest that this outcome might be avoided by structuring the cost recovery

[46] Glick and Sahn also found that the demand for primary schooling by the poor is substantially more price-elastic than that of the non-poor. Thus increasing public school fees will increase inequality in the distribution of primary school benefits as measured by the distribution of enrollments. This is the major behavioral factor explaining the distributional outcome of this simulation.

program in such a way that richer households or communities pay substantially higher fees with the proceeds used to subsidize poor communities. The political feasibility of this solution remains however an open question.

Finally the distributional implications of the last policy option, school consolidation, are qualitatively similar to those associated with the first option. However, the authors note that this option is not viable because it would make primary schooling less accessible for many children. Feasible options should be sought in the direction of adding teachers and classrooms to existing schools to reduce the need for multigrade teaching.

4.2. The General Equilibrium Framework

Fiscal incidence is concerned with the impact of the operation of the public budget on the distribution of the living standard usually represented by the distribution of real income. The estimation of fiscal incident entails the comparison of income distribution with and without the operation of the tax-benefit system under consideration. The traditional approach to incidence analysis is essentially a partial equilibrium one. In the case of tax incidence, for instance, the allocation of the tax burden is based on some shifting assumptions within the confine of a given market. McLure (1975) discusses the shortcomings of this approach. In particular, he notes that the supply curve in one market represents the response of one industry to changes in relative prices taking into account interactions in markets for factors and for other products. Yet, the standard partial equilibrium analysis fails to take these interactions into account, hence the appeal of the general equilibrium approach[47].

In this section, we focus on two basic issues. The first concerns the determinants of incidence within a general equilibrium framework. The discussion of this issue will refer to a simple analytical model and to an applied large scale general equilibrium model. Both types of models rely on the representative household (RH) approach. The

[47] Devarajan, Fullerton and Musgrave (1980) compare the standard approach to general equilibrium analysis.

second issue is therefore related to extending the RH approach to better account for agent heterogeneity.

The Representative Household Approach

A general equilibrium model is a logical representation of a socioeconomic system wherein the behavior of all participants is compatible. The key modeling issues thus entail the following: (1) the identification of the participants, (2) the specification of individual behavior, (3) the mode of interaction among socioeconomic agents, and (4) the characterization of compatibility. The basic Walrasian framework serves as a template for most applied general equilibrium models. There are two basic categories of agents: consumers and producers, which are also referred to as households and firms. The behavior of each economic agent is supposed to conform to the optimization principle, which holds that the agent attempts to implement the best feasible action.

Interaction among economic agents is supposed to take place through a network of perfectly competitive markets. Market interaction is a mode of *social coordination* through a mutual adjustment among participants based on quid pro quo (Lindblom 2001). Market participants are buyers and sellers whose supply and demand behavior is an observable consequence of the optimization assumption. In this setting, behavioral compatibility is described in terms of market equilibrium. General equilibrium is achieved by an incentive configuration (as represented through relative prices) such that, for each market, the amount demanded is equal to the amount supplied. Alternatively, we can say that, when the economic system is in a state of general equilibrium, no feasible change in individual behavior is worthwhile, and no desirable change is feasible.

The above characterization of a general equilibrium system leads to the fundamental view that fiscal incidence is determined by the underlying structure of the economy as represented by *individual behavior* and *social interaction*. Incidence analysis in a general equilibrium framework can be traced back at least to Haberger's classic 1962 paper on corporation income tax. The Harberger model is a two-sector model that is consistent with the Walrasian template. The economy produces two commodities **x** and **y**, using two factors of production, capital and labor. Perfect competition prevails throughout the economy. Firms maximize profit subject to a technology characterized by constant returns to scale. The total supply of each factor of production is fixed and all factors are fully employed[48]. There are two representative consumers in the economy who own all factors of production. Their income is therefore a function of relative factor endowments and possible transfers from the government. Consumers maximize utility subject to budget constraints. Each such constraint can be written in terms of *sources* and *uses* of income. This is a summary representation of the economic environment of the consumer that is affected by various taxes and public spending.

The Haberger model has been used to identify the determinants of fiscal incidence within a general equilibrium framework (McLure 1975, McLure and Thirsk 1975a&b, Devarajan, Fullerton and Musgrave 1980). We briefly consider some of the findings emerging from that work. McLure and Thirsk (1975a) analyze the incidence of several types of taxes within this framework, including a tax on capital income in one sector, and selective commodity taxes. In each case, they demonstrate how the tax affects both the sources and the uses of income for each representative socioeconomic group considered. In the case of corporate income tax in sector **x** of the economy, the immediate impact on the sources side is to reduce the net income received by the owners of capital or stockholders.

What happens next depends on the degree of *mobility* of this factor of production. If capital is fully mobile, the owners will shift the factor from the taxed sector to the untaxed one (which has higher net returns) until net returns are equalized throughout the economy. The assumed structure of the economy is such that the allocation and price of labor remained unchanged. Thus the mobility assumption ensures that the burden of a corporate income tax in one sector of the economy is shared by all owners of capital throughout the economy.

The incidence of the corporate income tax on the uses of income depends on two key elements: the induced change in relative commodity prices and the pattern of consumption. In the particular case considered by McLure and Thirsk (1975a) the cost and price of output will rise in sector **x** relative to **y**. The assumed pattern of consumption leads them to the conclusion that capitalists lose out relative to the workers

[48] This implies that factor prices are fully flexible.

as a result of the change in relative prices. If capital were immobile, there would be no factor returns equalization nor would there be changes in relative commodity prices. In that case, the entire burden would be borne by owners of capital in sector **x**. Also, there would be no redistribution in the uses of income.

The case of a sales tax is analyzed in a similar fashion. In particular, consider a sales tax imposed on the output of sector **x**, which is assumed to be capital intensive relative to the other sector. In other words, the capital labor ratio in industry **x** is higher than the overall ratio in the economy (Devarajan et al. 1980). Thus the price of capital will fall relative to that of labor. The consumer with the more *capital-intensive factor endowment* would suffer a greater loss in nominal income. The tax-inclusive price of commodity **x** would rise relative to the untaxed commodity. As before, the impact on consumers' economic welfare hinges on consumption patterns.

The above discussion of incidence analysis with the Harberger model clarifies the structural determinants of fiscal incidence. A change in relative factor or commodity prices creates incentives for economic agents to change behavior. When a tax lowers returns on one factor relative to another, because of the assumed optimizing behavior of economic agents, factor owners see this as a signal to shift the employment of the factor from the taxed sector to the untaxed industry. The effective shift is limited by the degree of factor mobility possible given the institutional framework. Perfect competition entails perfect mobility and price flexibility which lead to factor price equalization across sectors and changes in relative commodity prices. Income losses or gains are determined by relative factor endowments. The impact recorded on the uses of income is determined by consumption patterns.

While the Harberger model is useful in helping identify the key parameters underpinning fiscal incidence in a general equilibrium framework, the two-sector two-consumer model of a closed economy is too simplified to fully capture the richness of behaviors and interactions observable in a real open economy. The study by Devarajan and Hossain (1998) of net fiscal incidence in the Philippines discussed in section 3 above is based on a more elaborate computable general equilibrium model of an open economy. The authors highlight four features of this model that affect the interpretation of the results from empirical implementation. First of all, domestic goods and imports in the same sector are assumed to be imperfect substitutes. This means the removal of a 10 percent tariff on a given commodity will lead to less than 10 percent reduction in the price of the domestic substitute. Second, the model accounts for inter-industry transaction through an input-output table. This feature allows the model to track the cascading effect of an excise tax. A tax on oil for instance will spread beyond final energy consumption to affect final goods whose production uses oil at some stage. Third, the tax rates used are effective and not statutory. Finally, simulations are conducted under a revenue neutrality constraint. This means that if an indirect tax is removed, it must be replaced by an equal yield income tax that preserves government revenue. This constraint allows the authors to focus on the pure price-distorting effects of the tax system.

Empirical implementation of CGE models of the type used by Devarajan and Hossain (1998) for fiscal incidence analysis requires a data framework that clearly shows both the sources and uses of income for each agent, and the interconnections among these. A social accounting matrix (SAM) provides such a framework[49]. The matrix reflects *the circular flow of economic activity* for the chosen year (known as base year). It is an analytically integrated data set showing the interdependence of various aspects of the economy, such as production, consumption, trade, accumulation, and income distribution.

Table 4.3. Structure of a SAM for an Open Economy

	Activity	*Commodity*	*Factor*	*Household*	*Government*	*Investment*	*World*	*Total*
Activity		domestic sales			export subsidies		exports	total sales
Commodity	intermediate consumption			household consumption	government consumption	investment		total demand
Factor	GDP at factor cost							GDP at factor cost
Household			GDP at factor cost		transfers		foreign remittances	household income
Government	indirect taxes	tariffs		income tax				government revenue
Savings				household savings	government savings		foreign savings	total savings
World		imports						total imports
Total	production cost	total supply	GDP at factor cost	total household expenditure	government expenditure	total investment	total foreign exchange	

Source: Adapted from Robinson (1989)

[49] This account draws heavily from Essama-Nssah (2006).

A SAM is a square matrix, the dimension of which is determined by the institutional setting underlying the economy under consideration. Each account is represented by a combination of one row and one column with the same label. *Each entry represents a payment to a row account by a column account*. Thus, all receipts into an account are read along the corresponding row, while payments by the same account are recorded in the corresponding column. In accordance with the principles of double-entry bookkeeping, the whole construct is subject to a consistency restriction that makes the column sums equal to the corresponding row sums. This restriction also means that a SAM must obey Walras' Law in the sense that, for an *n-dimensional* matrix, if the (n−1) accounts balance, so must the last one. Table 4.3 shows the structure of a SAM for a model of an open economy[50].

Linking a CGE Model to a Microsimulation Module

The RH approach usually considers a limited number of representative households, anywhere between two (e.g. rural and urban) and 12. In the context of analyzing the distributional impact of policies, Savard (2005) compares the performance of the standard RH-CGE framework with that of a two-module framework where a CGE is linked to a microsimulation model. He finds that the modular approach outperforms the RH approach. The basic reason for this outcome is the use of the RH entails a loss of information about *heterogeneity* in terms of agents' behavior and endowments, a key determinant of policy incidence. The information loss is a result of modeling aggregate outcomes presented in a SAM as if they represented the behavior of a group of homogenous agents. In the extreme case where one focuses only on two representative households such as rural and urban, it is evident that much of the within-group heterogeneity (both behavioral and in endowments) is lost. Yet, this heterogeneity underpins within-group variance in response to policy.

If it is desirable to link a CGE model to a microsimulation model in order to improve fiscal incidence analysis, the issue then arises as to how this could be done. One possible approach is to fully embed the household module within the CGE model so that

[50] Note that the account labeled "Activity" represents the production sphere of the economy. "Commodity" stands for markets and "World", for the rest of the world.

it becomes an integral part of the overall model. This could involve thousands or tens of thousands of households depending on data availability. Boccanfuso and Savard (2007) call this approach the integrated multihousehold approach (IMH) and note several difficulties associated with its implementation. The fact that these household must sit within the underlying SAM creates challenges for data reconciliation to ensure that the SAM balances. Even if this step were successful, there is no guaranty that numerical resolution will be achieved easily. A second approach described by these authors as the micro-simulation sequential (MSS) approach entails linking the two modules in a top-down fashion through some linkage variables. In this case the microsimulation component could be based either on the envelope or the discrete choice framework.

Boccanfuso and Savard (2007) use a much simpler top-down approach to simulate for Mali the poverty and inequality implications of the removal of cotton subsidies in developed countries. The CGE model is a standard representation of a small open economy with 17 sectors of production subject to constant returns to scale. The assumption of small open economy implies that world prices are taken as given. Domestic goods are imperfect substitutes to foreign goods. The CGE component includes a single representative household since household heterogeneity is handled at the level of the microsimulation module. This bottom module is based on a sample of 4,966 households. Even though income and expenditure functions used in the microsimulation module are similar to the one for the RH in the CGE component, some behavioral heterogeneity is achieved by calibrating these functions not on the aggregate data in the SAM, but on household-specific information found in the survey. The income equation for each household specifies the income of each household based on the sources and relative endowments observed in the survey. Observed factor endowments are considered exogenous.

Fiscal incidence analysis within this framework is analogous to the envelope approach. Given the baseline, change the tax-benefit system within the CGE model and simulate the variation in factor payments induced by this policy reform. Bring these results into the microsimulation and use the income equations to estimate the implied variations in gross and disposable income. Next, use variation in disposable income to infer variation in real consumption. Standard indicators can then be computed to assess the distributional implications of the policy reform under consideration.

5. Concluding Remarks

This paper surveys basic concepts, methods and tools commonly used in *fiscal incidence analysis*. Such an analysis seeks to identify the *winners* and *losers* from the operation of the net fiscal system and to determine the social desirability of the associated distributional changes. As such, it is an exercise in *social evaluation* generally understood as an assessment of variations in individual and social welfare attributable to the implementation of public policy. In general, this evaluation entails a comparison of the distribution of an indicator of the living standard (e.g. real income or expenditure) with and without the tax-benefit system. The assessment can also be based on the distribution of *benefits* and *burdens* associated with fiscal policy.

The effective distribution of benefits and burdens flowing from government intervention is an outcome of interaction among three types of decisions, the first two of which are collective while the last is individual. The first collective decision determines the *size of government* from the appropriate role of the state in supporting individuals as they seek to realize life plans which they have reason to value. This fundamental consideration gives legitimacy to a tax system. The second collective decision concerns the value judgments defining social desirability for a distribution of net benefits from government activity. *Progressivity* is the operative concept in assessing the redistributive effect of public policy. Progressivity implies that benefits and burdens must be distributed disproportionately in favor of the poor. Burdens should be distributed according to the capacity to bear and benefits according to needs. Finally, one must account for individual reactions to these collective decisions. A tax-benefit system creates incentives for individuals to adjust their behavior in order to maximize their share of benefits and minimize their share of burdens. These reactive decisions attach a social cost to progressivity, the deadweight loss.

The interaction between collective and individual decisions creates a need for modeling approaches to account for individual behavior and social interaction.

Behavioral approaches are particularly useful for the construction of a counterfactual distribution of economic to back up *causal analysis*. Behavioral models are commonly based on the principles of optimization and market equilibrium. The microsimulation approach offers the possibility to fully account for the observed *heterogeneity* of socioeconomic agents and improves the accuracy of the estimation of the *budgetary impact* of a given policy. Computable general equilibrium models are more suitable for accounting for the interconnectedness of sources and uses of income of various agents. Such models are also designed to better track second and higher order effects of policy. Linking a general equilibrium model to a microsimulation model enhances the ability of the resulting framework to deal with both heterogeneity and general equilibrium effects.

There are a few *policy design lessons* that emerge from this review. In principle, individual income and wealth taxes are the most capable of redistributing income. The progressivity of such taxes depends on the base, the top marginal rate, the number of deductions and the compliance rate. There are institutional factors, such as the existence of a large informal sector, that limit the effectiveness of income tax in developing countries. This is why these countries tend to rely more on indirect taxes. The regressivity of these indirect taxes can be reduced through targeted exemptions.

To draw proper policy implications from incidence analysis, it is important to fully understand what drives the observed outcomes along various dimensions of the living standard. In particular, it is important to consider factors that prevent poor people from making use of available public services. This consideration must go beyond economic to cover cultural and political economy factors. Finally, standard incidence analysis focuses on the distribution of publicly provided inputs to the living standard. Since the ultimate goal of public policy is to improve people's lives, two basic questions deserve special attention. What type of a living do people manage to achieve from public spending out of tax revenues? To what extent does fiscal policy equalize opportunities for well-being among citizens?

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